

40. 50. 60.
80. 100. 120.
160. 200. 240.
280. 320.

5. 10. 15.
6. 8. 10.
12. 16. 20.
24. 32. 40.

THE NAVIGATOR

Shewing and explaining all
Chiefe principles and parts
both *Theorick* & *Practick*, that are
contayned in the famous Art of
NAVIGATION.

WITH

A new and Admirable way of Sayling
by the Arch of one of the greatest
Circles.

Contayning excellent Tables most exactly
Calculated, shewing the true Proportion of
all Arcs in respect of the Meridian.
With the proper Phraijes Used in Work-
ing of a Ship according to all Weathers.

By Captain Charles Saltorn-*Stall*.

London Printed for Geo. Hawkes, 1672.



Jeremiah Chipondy
~~1653~~ 1653

Jeremiah Chipondy
on ship board



TO
THE RIGHT HONORABLE
THOMAS.

Earle of ARVNDEL and SURRY,
Lord High Marshall of England,
Knight of the Noble Order of the
Garter, and One of his Majesties
most Honourable Private
Councell.

RIGHT HON:



When a right noble disposition is once generally discovered, it emboldens men that are meere Strangers, to presse into theyr presence, provided theyr errants are onely concerning vertuous Actions, which motive hath made these rude lines voyd of all Rhetoricke, runne with such hast to your Lordships hands, intreating for a favourable acceptance of a
few

The Epistle Dedicatorie.

few experimentall Conclusions, performed in the admirable Art of NAVIGATION, by one that is as much a stranger to your Lordship, as I am to the Land and my Kinsfolkes; many long Voyages having banished me from the remembrance of them both; so that I may justly affirme, I am scarce knowne to either of them, except now by reading my Name, they rub up their remembrance and find me revived, who have layne a long time rak'd up in the embers of oblivion. Howsoever it happen in that respect, it is a matter very indifferent to my mind; for I onely desire, that these my Practices may prove pleasing to your Lordship, which although they are delivered in a blunt phrase, I assure you (*Right Honourable*) will speake the plain Truth, otherwise they should not dare to desire such Noble protection, if they could not deserve and merit that which is most esteemed amongst vertuous minds. Therefore I doe in a manner assure my selfe they will gaine your gracious aspect, which is too great a reward to let fall upon the first borne of my braine, and so will bind mee perpetually to study, how to illustrate my present performance, that it may ever gaine Your Honours good will.

*Your Lordships, to Command
in any Service:*

CHARLES SALTONSTALE.



TO ALL GENEROVS AND industrious SEA-MEN.

Kind Companions :



Could not chuse but present these few lines to your favourable acceptance, before you proceed to take a farther view of the following Worke, that none might hereafter mistake my intent, and imagine where Ignorance is openly pointed at, that I meant any of you in particular : For Industry and Art, are both sufficient Bucklers to shield you all sure enough from any such danger. But you know there is a certaine kind of Creature, crept into the confines of most warlike Ships, whose rare and illiterate allegations are ever absolute against the Rules of Art, and all those which bring about their Conclusions according to such directions ; because they are cleane contrary to their constitutions. If such men as they snuffe up Pepper, and so fall a sneezing out their malice against the matter, which in no wise they are able to mend, the distast will give me no discontent ; for their pallates cannot relish the excellent rules of Reason ; therefore I am certaine will suck out nothing but the sowre sauce, which will make them vomit up their venome, bequeathing all the rest to the intelligent Artists, men of another temper, whose tastes are able to distinguish what variety of delicate faire Fruits they are freely feasted withall. Their goodnesse I doe not doubt, but time will so well discover, that some gratefull acknowledgement shall be powred upon the first Planter ; howsoever it fortune, I doe not desire to find favour through a flattering Epistle, presuming the ensuing matter must merit that, or else I have much mistooke the marke, and rooke a great deale of paines to little purpose. So farewell.

Yours, how you will.

Charles Saltonstall.

To his Friend the Author.

What shall wee give the Navigator heere ;
For Bayes too meane an offering doth appeare :
Although that Bayes and Rosemary both bee
Used to grace a Bridall commonly.
Then Sayless all, pray come to the Wedding
Of Art and Experience, with this bidding :
If for the Wedding-house you chance to looke,
The Wedding is kept heere within this Booke.
Then come you merry Lads, that have beene ride,
And leave your Wenches, make this Booke your Bride.

EDVVARD BLAKE.

To the merry Marriners and Sea-men, the Navigator
wisth Health, Happinesse, and prosperous
Voyages.

You trusty Trojans, and you merry Greekes,
That doe ransack all the worlds Coasts, and Creeks,
The Navigator wistheth you all health,
And that you may bring home great store of wealth,
Which to performe, if you advice will take
That all prosperous Voyages you may make,
Hee shewes the way, that so you may come home
In due time to your Wives, who make their moane
Like chaste Penelope for her Ulisses,
Or like Niobe turne to Stones, but if wishes
Or the Navigators Art can preuyle,
To come backe to your Wives you shall not fayle.
And when you suddenly take them Napping
As they doe spinne on their wheelles at Wapping,
First giue your Wives I pray, a hearty Smack,
Then drinke the Navigators health in Sack,

Edward Flowerdewe.

THE

THE
NAVIGATOR.

[* *]

CHAP. I.

*The Division and Description of the whole Art
of Navigation.*



THE admirable Art of Navigation, is that which produceth most certaine and infallible Directions, how you shall sayle a Ship the most compendious Course betwixt any two Places that are never so farre Distant, if there be Sea or water sufficient for the Ship to swimme through : which knowledge is gained by getting the true Understanding of these two principall parts ; Namely the *Theoricks*, and the *Practicks*. For the Theorick will fully informe you of the composition of the *Spheare* in generall, and in particular of the Figure, Number, and Moti-

ons made in the Heavens, chiefly of the highest moveable, called (*Primum mobile*,) and likewise of the first, fourth, eight and ninth Heavens, the Theoricke will also informe you how the Elements are disposed, With their quantities, and scituations, especially in the composition of the earth, and waters, which make one absolute round body, with the nature and use of the Circles which are supposed to be contained in that Spheare, if you doe not endeavour to get this knowledge, you cannot desire the name of Navigator: The Practick part is properly placed upon the making and using of divers Instruments, as Crosse-staves, Back-staves, Nocturnals, Planisphaeres, instruments for the Moone and Tydes, with divers others: Yet there is one certaine Composition more rare then all the rest in the Practick of Navigation, which hath ever beene omitted by all men that have writ of the Art, And that is, the vnparalleled Fabrick of a gallant Ship, whose way of working, ruling, guiding, governing, and constraining to performe the expert Navigators pleasure in the Sea, hath at no time untill now beene explained by any Pen, But I could not let it passe any longer, because I knew with proper phrase how to performe it, which perchance hither unto hath hindered it from the public view, howsoever it hath happened I know not, but me thinks the divers Navigators which haue writ severally of the Art, should some of them haue remembred before this time to try how truly and lively they could haue layd forth their Skill in controlling, guiding, and working a Ship according to all weathers at Sea, by the expression of their pen: but I trust they will all pardon me for taking notice of their over-sight, if they will not, I assure him that thinkes himselfe the most sufficient that I doe not feare hee should draw forth a second description to make the matter appeare more lively in a lesse Compende.

CHAP.

CHAP. II.

*The Practicke part of working a Ship in
all weathers.*

FOR that part of Navigation which is performed by the practickall knowledge of working a Ship in all weathers at Sea, it is impossible for any to prescribe rules, or give demonstration by words to those which are altogether ignorant of Marine affaires, that they may reape any benefit or knowledge by it, although indeed, that whole Practicke part may be composed and delivered in proper Sea-phrases according to each severall materiall belonging and appertaining to a Ship compleatly rigged, with the use of each severall Rope in working and trimming sayles at Sea; But I pray, who would or could possible apprehend the reason of such a demonstration except an experienced Mariner, who will give you as little thanke for your labour in taking paines to advertise him of those things which all his lifetime he hath bin brought up to, as if you should goe aboard a Ship and shew the Master which is the Mayne bow-lyne; but because all Arts and Sciences, are divided into two chiefe parts or principals, namely the Theorick and Practick, and in regard it is impossible, for any to be complear, without he hath attained to the true knowledge of them both being inseparable companions which ever waite upon perfection.) Therefore I could not now command my pen to passe any further forward, before it had first plainly expressed the proper way of working a Ship in all weathers, that it might prevent the censure of all such, as I am certaine will bee very curious in inquiring, whether I may not bee found lame in that Limbe, and so like themselves, should appeare most imperfect, (For with grieve I speake it) this Noble Art of Navigation had never more maimed and decrepped fellows (preferred through favour and fortune) so that now
adives

a dayes let one come aboard a tall Ship at Sea, and it will be very rare to find Ignorance out of the round-house, but commonly better Marriners and more sufficient men afore the Mast, which are turned Hawle-Bowlings through the avernesse of their fates, I should be very glad to see a more equall Ballance used, for the furtherance of the industrious and encouragement of deserving men; For, if this insufferable partiality should be of any long continuance, I feare in short processe of time, the compleat Marriner will very hardly be found aboard any Ship, although you search, Fore, and Aft, to the great dishonour of this famous Ile, which hath so long deservingly held the superiority of all other parts of the whole World, for breeding and bringing forth Famous Navigators. The *Hollanders* already beginneth to have us in Contempt, saying, hee is farre afore us, both for Ships and sufficient Marriners; but for the last, it may be soone answered, had not the former unoquall ballance, enforced our expert Saylers to seek if Fortune would be more favourable amongst them, they had not beene at this day in such a flourishing height; but swift Time is subject soone with his silent course to steale that out of remembrance, and so I doubt they will exceed us indeed, to our Nations dishonour. I will not draw forth this digression to any longer discourse, least my Rhetoricke should not relish in the Eares of all men, but will now returne, to this Practick part formerly expressed, that it may appeare in proper Sea-phrases, how a Ship compleatly Rigged should be worked both by and large in faire weather and Foulle; not expecting that any may reape knowledge by it, but only that Marriners may censure, for some I know being a little touched will say (as their common phrase is) if they had me at Sea, and turned me three times round, all my prescribed rules will be to seeke, but let them know (no) not if they turned the Ship threescore times round, and let it blow high, blow low, but I will worke the Ship as well in all assayes as ever they did, therefore to prevent such calummie, let all men consider this Practick part, in brieve following.

The Navigator.

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My Anchor is away.

THe winde is Roome, let fall your Fore-sayle, heave out Fore-top-sayle, heave out Main-top-sayle, hoice up Fore-top-sayle, hoice up Maine-top-sayle, lōse Sprit-sayle, heave out Mizzen-top-sayle, square your Sprit-sayle, a brave gale, let us have her in all her Canvasse, heave out Sprit-sayle, Top-sayle, Fore-top-gallant-sayle, Maine-top-gallant-sayle, hoice up your small-sayles, hawle aft your fore-sheats, I keepe my Mayne-sayle furled, because J hold if your Fore-sayle and Fore-top-sayle be good sayles, that the Ship maketh better way now, then if her Maine-sayle were downe, which would becalme her Fore-sayle, and Fore-top-sayle, and the Ship steereth best with her Head-sayles. J have of purpose omitted the cleering each severall Rope, now at my setting sayle, onely you must imagine, that the Sheats are all hawled home, and the yards hoysed up, and then you have her compleat, under sayle right affore.

A fresh-Gale.

THe wind bloweth fresh, hawle downe your Fore-top-gallant-sayle, hawle downe Maine-top-gallant-sayle, in Sprit-saile-top-saile, let goe Sprit-saile-top-saile, Sheats, hawle home his Clu-lines, in Fore-top-gallant-saile, in Main-top-gallant-sayle, in Myzen-top-sayle, let goe Top-gallant-Sheats, cast off Top-gallant bow-lynes, hawle home Top-gallant Clu-lynes, the Mtzen Top-sayle is in, and so is all the rest of the small sayles.

A Scant-wind.

THe winde Scanteth, vcare-out some of the weather Sheat of the Fore-sayle, let goe your weather-Braces, top
B your

your Sprit-saile, loose Mayne-saile, (the wind vereth forward) get too your Fore-tack, cast off your weather-Sheate, let goe your weather-Braſe, vere out some of the lee-Sheate, let fall Mainz-saile, get too Maine-tack, cast of Maine-braſe, and Mainz-top-saile, hawle aft Maine-sheate, the winde is Sharpe, in Sprit-saile, square Sprit-saile-yard, let goe Sprit-saile Sheates, hawle up Sprit-saile Clu-lynes, get Maine-bowlyne, in Block, hawle forward Maine-bowlyne, hawle Maine-top-saile Bowlyne, hawle tought, Fore-bowlyne, and Fore-top-saile Bowlyne, hawle aft Maine-sheate, hawle abroad Myzen, set in your Lee-braces, and keepe her as neare as she will lye; here you have all your sayles, Trim'd Sharpe or by, a wind.

A Stiffe Gale.

THe wind blowes Frisking, settle downe your Fore-top-saile, settle Maine-top-saile, (much wind) hawle downe Fore-top-saile, hawle downe Maine-top-saile.

A hard Gale.

IT bloweth hard, take in our Top-sailes, let goe your lee-Braſes, and cast off your Bowlynes, braſe your Weather-Braſes, and spill your Sayles, let goe Top-saile Sheats; hawle home Top-saile Clu-lynes, the sailes are furi'd; square your Top-saile yards; here have you the Ship brought into her courſes of low-sailes.

A Storme.

IT bloweth extreame, and like to overblow, see that your Maine-Hallyards be cleere, make all your geere, cleare to lower the Maine-yard, hawle downe the Myzen, cast off Top-saile Sheats, Clugarnets Buntlynes, Leechlynes, Lifts, and all your other geere, (and Lower) bring the yard downe, hawle

The Navigator.

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to the Capſten, the yard is downe, get the Saile together, and Furl it ſure, make faſt the yard for Traverſing.

A growne Sea.

THe Sea is much growne, we make foule weather, looke our Gunnes be all faſt, it is better Spooming, put the Helme a weather, and mind what is ſaid, right your helme, let riſe Fore-tacke, ſettle our Fore-yard, the Fore-ſayle giveth way, (lower a Mayne) hawle the Sayle into the Ship and looſe it from the Yard, get too the Fore-Bonnet, make all cleare and hoyle the Fore-yard; heere have you the Ship brought from all the Canvaſſe to a Fore-bonnet ſpooming before the Sea.

A fierce Storme.

STarbord, Hard up, Right, Port hard, more hands (he cannot put up the Helme) the Sea breakes dangerous, have a care what is ſaid, and ſtand ſtoutly to the Helme, ſhall we get downe our Top-maſts, no let all ſtand, the Ship is the holſommer, and hath better way through the Sea, for their being a loſt, (if you have Sea-roome, it is never good to ſtrike your Top-maſts either under the Sea or before;) thus much for handling the Ship By and Large, in Faire-weather and Fowle, now a word or two of turning to Windward.

To turne to Windward.

MY Courſe is N. and the Wind is at N, E. get your Star-board-Tackes aboard, caſt off your weather Braces, brace upon your Lee-Braces, and hawle forward by your weather Bowlines, hawle tought all your weather Bowlynes, and ſet in your Lee Braces, hawle abroad Myzen, and keepe her fall, and By, as neere as ſhe will Lie, *How wind you, N. N. W.* aquade winde (no Neere) hard no neere, the winde

veareth forward, we shall have a westerly wind, *How wind you*, W, N, W. hard no Neere, *How wind you*, S, W. (make ready to goe about) we shall lye our course the other way (*Ready, Ready*) no Neere, give the Ship way that she may Stay, (a Lee the Helme) veare out fore Sheate, cast off Lee-Brases of your Fore-faile, and Fore-top-faile, brase upon the weather Braces, (the Fore-faile is a back Stayes) hawle about Maine-faile, let rise Maine Tacke, cast off your Larboard Braces, let goe Maine Bowlyne, and Maine-top-faile Bowlyne, hawle forward by Larboard, Maine Bowline and Maine-top-faile, brase upon Starboard, Maine Brase and Maine-top-faile, get too Maine-Tack, and then hawle aft Maine Shear, let rise Fore Tack, veare out weather Shear, get too Fore tacke, let goe Fore-Bowline, and Fore-top-faile, hawle aft Lee Shear, hawle tought Maine Bowline and Maine top-faile, hawle tought Fore Bowline and Fore-top-faile, set in Lee Brases, Fore and aft, and the Myzen shifted, keep her as neere as shee will Lye, no Neere, *How wind you*, N. and a weather, no Neere, keepe her full, the wind is at West, keepe her as neere as she will Lye. *How wind you*, N, N, W. no Neere, veare out some of the Maine Sheate, and ease your Lee-Brases, keepe your course, (the wind is broad) veare out some more of your Maine Shear, let goe your Bowlines, and Lee-brases, the wind is *Quartering*, let rise your Fore-Tack, hawle aft the weather-Sheat abaft the Anchor Stock, brase upon your weather Brases, hawle up your Myzen and loose Sprit-fayle, a brave gale, the wind is all aft, let rise Maine-tack, hawle aft Maine-shear, square Sprit-fayle and all the rest of our fayles; here have you the Ship in all her Canvasse againe, Steering right before the wind as she did at the first setting fayle, having beene worked in all manner of weather, and with all sorts of winds; therefore I will only proceed concerning how the Man-of-Warre ought to be worked, in all aflayes, and so will leave you the Practicke to censure.

A Man of Warre.

Our Man-of-Warre is compleatly Rigged, and fitted with all manner of materials, a choyce crew of Sea-men aboard, and now lyeth at *Hull* in a good Latitude, dayly expecting that a faire Fortune will appeare within her Horizon, the day breakes, bravely (up youths into the Tops and looke abroad now at Sunne-rising) looke to the Westward, if there be no plyers that are Nipt with the Easterly wind, (*A Sale, a Sale*) faire by us (how stands she) it is one that is plying to windward, she stands with her Larboard Tackles aboard, (O then she lyes; to the Southward with the Steame a brave Chase) wee see her here upon the Decks, set her by the Compasse (how beares she) due S, W, a good man to the Helme, let fall Fore-saile, get Larboard tackes a board, downe Main-saile, heave out Fore-top-saile, heave out Main-top-saile, hoysse up Fore-top-saile, hoysse up Main-top-saile, let fall Sprit-saile, out Maine-top-gallant-saile, out Fore-top-gallant-saile, out Maine-top-gallant-saile hoysse up our small Sailes, hoysse up your Mizen, heave out our Myzen-top-saile, have a care of your hand at the Helme, (keepe her thus) well Steerd, the Ship makes brave way through the Sea, and we raise her apace, if she keep her course wee shall be up with her within two glasses, (Starboard) keepe the chase open with the Itch of the Fore-saile, well (Steered) keepe her thus, come ast all hands, the Ship will saile better by a Top-saile, for she is too much by the head, sit all still that the Ship may runne true through the Sea, it is a great Ship (no force) shee hath the bigger hold, and carries more goods, (Port) the chase is about. (Port hard) let rise Maine-tacke, let rise Fore-tacke, brace upon your Larboard braces, get too Starboard Maine-tacke, and Starboard Fore-tacke, cast off all your starboard braces, (steady) right your Helme (well steerd) the chase clings up close to the wind, keepe her open under our Lee, Gunner see that all

our Gunnes be cleere, and that nothing petter our Decker, for we shall be straight up with her (Starboard) the chase payes away, more roome (Starboard hard) veare out some of the Maine Sheate, and Fore Sheate, cast off all your Larboard braces, (steddy, steddy) keepe her thus, well steerd, the chase stands roome, her Sailes are trimm'd before the wind, (Starboard hard) let rise Maine-tacke, let rise Fore-tacke, hawle aft Maine-Sheats, hawle aft Fore Sheates, we have a Sterne chase, hawle up one Maine-saile in the Brayles, the Ship will steere the better with her head Sailes, and will have quicker way through the Sea, we fetch upon her hand going, the chase hawles up his Maine-saile and furler it, she puts abroad her wasse cloaths, she will fight with us before the wind, (come up alow yong men) and furler our Maine-saile, Sling our Maine yard, with the Chaines in the Maine-top, Sling our Fore-yard, put abroad our wasse cloaths (is all things cleere below) leave not so much as a Spun yarne amongst our Gunnes, downe with all Hammacoes, and Cabbins that may hinder or hurt us, Gunner have you all your geare in a readinesse, is there store of Cartrages ready fill'd, all manner of shot at the Mainemast, Sponges, Rammers, Ladles, Primming Irons, and Primming hornes, Lynstockes, Wads, and water sufficient for the severall Quarters, be sure that none of our Gunnes be cloyd, and when we are in fight, ever load with Crosbar and Langrell, alwaies observing to give fire when the word is given, see that there be halfe Pikes and Javelings in a readinesse, and that all our Murtherers and Stockfowlers, have their Chambers fill'd with good Powder and bagges of small Shot to load them, that if we should be laid aboard we may cleere our Decks, we are almost up with our chase, she is full of men, it is a hot Ship, but she is deep & very soule (come cheereley my hearts) it is a Prize worth fighting for, the chase takes in her small Sailes, up aloft youths, take in our Top-gallin-sailes, in Sprit-saile-top-saile, in Mizzen-top-saile, take in our Sprit-saile, & bring the yard alongst-ships, she puts abroad her colours, it is the Ragged Staffe, boy up & put abroad St. George
his

his colours in our Maine-top ſtep aſt at hand and put abroad our bloody Antient, ſhe ſettles her Top-ſailes, we are within ſhot, let all our Gunnes be looſe in the Tackles, and the (Ports) all knockt open that they may runne out when the word is given, up Trumpet and haile our Prize, ſhe answereth us againe with her Trumpet, hold faſt Gunner, do not give fire untill we haile him with our voyces (Port) edge towards him, he fires his broad ſide upon us (what cheere my Mates, is all well betwixt Deekes, yea, yea) only we are rackt through and through, (no force) it is his turne next but give not fire at any rate untill we are within Piſtoll ſhot, (Port) edge towards him, he plyes his ſmall ſhot, hold faſt Gunner (Port) right your Helme, we are cloſe aboard (Starboard) give fire Gunner, answer him in his owne Language, he gaules us with his ſmall ſhot. Gunner clap in ſome caſe, ſhot into thoſe Gunnes which you are now a loading, we are ſhot a head, he lyes broad off to the Southward. that he may fire his other broad ſide upon us, (Starboard hard) get too Larbord Fore-racke, trimme your Top-ſailes, runne out our Larbord Gunnes, he fires his Starboard broad ſide, upon us, and powres in his ſmall ſhot. (Starboard) give not fire untill they fall off, that the prize may receive our whoie broad-ſide (Steddy a Port) give fire Gunner, his Maine-top-maſt is by the board; and our laſt broad ſide hath done great execution (cheerely my Mates, the day will be ours) he is ſhot a head, and beares up before the wind to ſtop his Leakes, (keepe her thus) well ſteer'd, wee are to the Southward of the Prize (Port hard) beare up before the wind, that we may give him our Starboard broad Side, Gunner is there good ſtore of Caſe ſhot in our Gunnes (yea, yea) (Port) edge towards him, Gunner when you give fire, bring your Gunnes to beare amongſt his men upon the Deekes. that they may ſhare our caſe-ſhot, (well ſteer'd, wee are cloſe aboard, give fire (Starboard) well done Mr. Gunner, they lye heads and poynts aboard the chaſe, we are ſhot a head, he ſtrikes his Fore-top-ſaile, he would fall a Sterne, hee hath his belly full, but wee muſt

must not leave him thus, aluffs into the wind, he braces his Fore-saile and Fore-top-saile a Backe-stayes, (Port hard) get too Starboard Maine-racke and Starboard Fore-racke, (aluffe) hawle forward Maine Bowline, and Maine-top-saile Bowline, hawle forward Fore-Bowline, and Fore-top-saile-Bowline, (aluffe, aluffe) well steer'd (no neere) come ready, ready, that we may goe about, wee shall fetch her againe upon this board, a Lee the Helme, the Fore-saile is a Backe-stayes, let rise Maine-racke, let goe Maine-Bowline and Maine-top-saile Bowline, hawle about Maine-saile, get too Maine-racke, and Fore-racke, hawle ast your Maine-sheate and Fore-sheate, trimme your Top-sayles (no neere) hard no neere, the Ship will stay, flat in your Fore-saile shee falleth off againe (thus) (warre) (no more) (aluffe) the prize puts abroad a white flag of truce, (aluffe) we will weather him, and then keepe him under our Lee, he hailes us with his voyces, mind what he sayes, (Quarter for our lives, and we yeeld the Ship and Goods) good quarter is granted (provided) that you forthwith take in all your Sailes and furle them, untill wee come aboard with our Shallop, if you unloose a knot of Saile expect our broad-side and no Quarter, thus leaving the Man of Warre, to enter his Prize, I will likewise leave you thus much of the Practicke part of Navigation, to all your Indicuous censures, by which you may perceive, that I have turned and worked the Ship in all assayes; with words and proper Seaphrases: And if I were at Sea, I should performe it both by word and deed. Therefore let not Ignorance, the arch enemy of Arts, deeeive himselfe, and thinke that three times turning will turne my brayne, but that I will turne to windward with him for all his shooes in his shop, and when I have done, as will easily turne him in the Theorick, which way I list, As J can the Ship with the Practicke.

Of the Compasse.

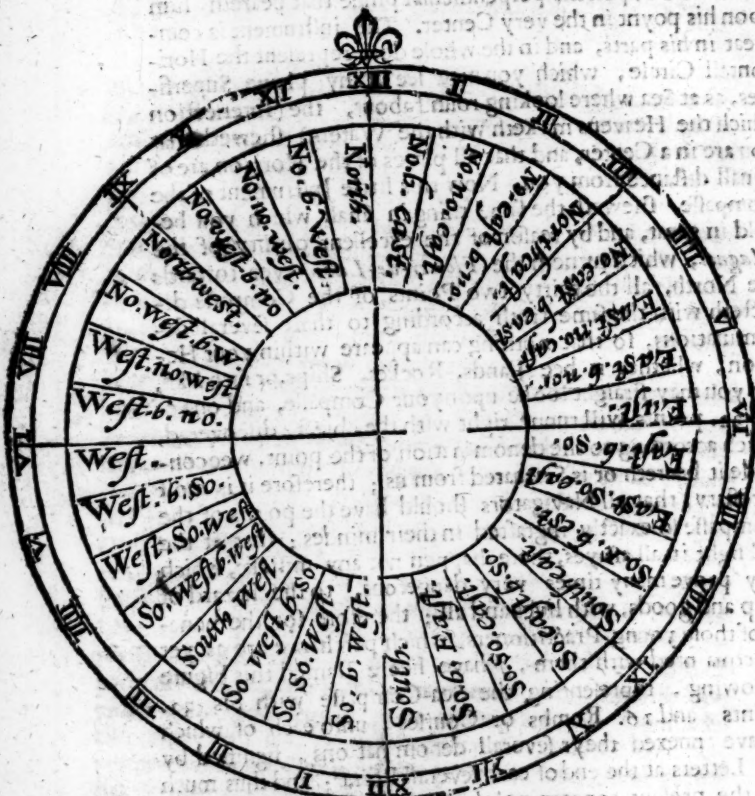
THe foure principall Handmaids that alwayes waite upon the expert Mariner, and crowne his Conclusions with everlasting credit, are these loving Sisters, *Arithmetick*, *Geometry*, and *Astronomy*. By the operation of these excellent Arts Navigation is dayly practised by some few expert Sea-men, but much more abused by many hundreds of Ignorant men, that know little or nothing what belongeth to any of them; yet will undertake to direct a Ship to any place upon the Terrestrial Globe, wholly trusting that favourable Fortune will make them famous; but oftentimes a disastrous period concludes their undertakings, with the lamentable losse of divers mens Goods and Lives; But to returne to the matter intended I would have it understood, that although I have named these foure Arts, as the originals of Navigation; yet that I doe not meane in this place to insist upon each severall Science in particular; for then I should increase my discourse to a great volume, before I come to the purpose that I saynt at; Therefore it is supposed first that hee that intendeth the Art of Navigation hath all manner of Arithmeticke in a read nesse, which if he want, there are divers Bookes already extant that will instruct him, as namely, *Record. Bakers*, *Blundevell &c.* And for Geometry, *Speedels* Extractions, and *Diggers* his Geometry, with many others. And for Naigation, and Astronomickall knowledge, so much as is necessary for a Sea-man, will be discovered in the Projection, and use of divers Instruments of Navigation, which will hereafter follow in the ensuing worke.

And now to proceed in a Regular forme, for the attayning the full knowledge of this famous Art, the *Sea-Compass* presents himselfe as the first principall, framed by the operation of the *Magnet*, which although it be a thing in respect of the quality beyond our Capacities; yet his uses is

the first part that is necessarie to be understood, and must even be the foundation to all future conclusions, (As letters are to expresse Language) and not unfitly be compared as a beginning of the same nature; for first you teach your children to know the letters by name, and so in the like manner we teach our youths, and beyes (which wee intend to make Navigators) the poynts of the Compasse by name, reason as yet (being onely empty sound on both parts) then as you proceed to shew your Children the nature of joyning Letters, and making syllables of divers sorts and sounds, so we after the poynts are growne frequent and common, teach them to joyne or spell, by shewing them how the Winds bloweth, and demanding what poynt it commeth from, as likewise by setting the Capes of Land and the bodies scituated in the Heavens, (as Sunne, and and Starres,) and then requiring what poynt runneth with them; and now as Children which know their letters and syllables, attaine in short time to the reason of Reading, so our youths having once the 32. Poynts of the Compasse as perfect in generall, as East, West, North, and South, are to all men in particular, will in short space conceive by what reason wee guide the Ship, and shape our Courses betwixt place and place. The Compasse which wee use to direct our Courses by, is onely a Circle of some 8. or 9. Inches diameter, and is divided into 32. parts or Poynts, intersecting each other onely in the Center, and these Poynts have theyr severall denominations, as the Figure doth expresse the whole Circle which is divided into 32. equall parts or Poynts, (as is afore-mentioned) is likewise divided into 360. equall parts or Degrees; the Compasse also containeth 16. distinct Rombs or Courses, for each severall Course hath two of the poynts of the Compasse by which hee is expressed; as for Example, Where there is any place that is Scituated South-west, in respect of another place, wee say, the Rombe or Course that runneth betwixt them is South-west and Northeast, if the place beare

bore North, wee say the courſe is North and South . if Eaſt wee ſay, Eaſt and Weſt, &c. Now the Wyers being diſcreetly touched, and this plaine Superficies, or Fly-playing, at the leaſt motion upon his perpendicular pinne that beareth him upon his poynt in the very Center. The inſtrument is compleat in his parts, and in the whole doth repreſent the Horizontall Circle, which you may ſee in any plaine Superficies, as at Sea where looking round about, the (Interſection which the Heavens maketh with the Waters) ſheweth that you are in a Center, and that all places of the Horizon are of equall diſtance from you. Now this little Inſtrument of the Compaſſe, ſheweth the ſame thing in ſmall which you behold in great, and by reaſon of the excellent quality of the Magnet, which turneth the *Flower-de-Luce* ever towards the North, all the thirty two Pointes of the Compaſſe directeth with the ſame truth according to their ſeverall denominations, ſo that nothing can appeare within your Horizon, whether it bee Ilands, Rockes, Ships, or ſuch like, but you may ſtraight looke upon your Compaſſe, and one of the 32. points will runne right with the object diſcovered, which according to the denomination of the point, wee conclude it beareth or is ſituated from us; therefore it is moſt neceſſary, that all Navigators ſhould have the pointes of the Compaſſe ſo exactly ingrafted in their mindes; that at the firſt ſight in all aſſayes, there happen not any miſtake, which may prove many times very dangerous, to the hazard of Ship and goods, with lives and all; therefore for the benefit of thoſe young Practitioners, which perchance are as yet unacquainted with them, I have heere framed this Figure following, repreſenting the Sea-Compaſſe with his 32. Points, and 16. Rombs or Courſes, unto each of which I have annexed theyr ſeverall denominations, ſignified by the Letters at the end of each ſeverall Point; and thus much for the preſent concerning the Sea-Compaſſe as the firſt principall or part of Navigation, and not in this place to proceed to the manifold Concluſions which are performed

through his ayde and application, as will be manifest hereafter.



being thicker then the other, the next Circle being divided into 30. equal parts, representing the distance of 30. times the Diameter of the Earth is supposed to be the same.

The Ebbing and Flowing of the Sea, and the

Reasons of it. The next necessary to be learned in order by the Practitioner of Navigation, is to know the certain time of the Ebbing and Flowing of the Sea in all Ports, or Creeks, commonly called by the Sea-men, *The setting of Tides*; which by Experience is found to be governed by the Motions of the Moone; therefore, I will shew you now in the first place, her severall Courtes and when she hath swift Motion, because it will appeare more properly, where I shew you Arithmetically how to find the Moones age, and what other Conclusions are to be wrought by Arithmetick, which may bee, some of you that reade this Booke are not very expert in; wherefore, I will first shew the use of a small Instrument which I have heere framed, whereby the meanest Capacity shall be able, not onely to know the Age of the Moone, with what Flood or Ebbe it maketh in all the Channell, and in every Port or Creeke; but shall likewise be able to know what a Clocke it is at any time of Night; and divers other Questions in Navigation, onely by moving the Indexes of the Instrument, according as the question shall require, which I will shew at large how it may be performed, and then I will likewise shew how it is to be done by Arithmetick; but first for your Instrument it must be projected according to the following Figure. For the framing of this Instrument, you must have three small pieces of boards well playned and exactly divided, according to the same manner as I have formed it in the Figure, the biggest of which boards having the 32. Poynts of the Compasse, and the innermost Circle containyng 24. Houres, must be something



He next necessary to be learned in order by the Practitioner of Navigation, is to know the certain time of the Ebbing and Flowing of the Sea in all Ports, or Creeks, commonly called by the Sea-men, *The setting of Tides*; which by Experience is found to be governed by the Motions of the Moone; therefore, I will shew you now in the first place, her severall Courtes and when she hath swift Motion, because it will appeare more properly, where I shew you Arithmetically how to find the Moones age, and what other Conclusions are to be wrought by Arithmetick, which may bee, some of you that reade this Booke are not very expert in; wherefore, I will first shew the use of a small Instrument which I have heere framed, whereby the meanest Capacity shall be able, not onely to know the Age of the Moone, with what Flood or Ebbe it maketh in all the Channell, and in every Port or Creeke; but shall likewise be able to know what a Clocke it is at any time of Night; and divers other Questions in Navigation, onely by moving the Indexes of the Instrument, according as the question shall require, which I will shew at large how it may be performed, and then I will likewise shew how it is to be done by Arithmetick; but first for your Instrument it must be projected according to the following Figure. For the framing of this Instrument, you must have three small pieces of boards well playned and exactly divided, according to the same manner as I have formed it in the Figure, the biggest of which boards having the 32. Poynts of the Compasse, and the innermost Circle containyng 24. Houres, must be something

thing thicker then the other, the next Circle being devided into 30. equall parts, representing the disttance of 30. times 24. houres or 30. naturall Dayes, is attributed to the Sunne, the other Circle, and the uppermost of the three, having nothing graduated upon it, is attributed to the Moone, and hath his Index to be turned about as that of the Sunne, and may be turned or appoynd either to the 30. Dayes, containing the Computation of time, betwixt Change and Change, or to the 24. Houres, as likewise to the Poynts of the Compasses, and so may the Index of the Sunne bee applied, eyther to Time or the Poynts of the Compasses; which being made playne by some Questions, will appeare both delightful and most easie to be attayned unto, and I hope the illiterate man will find it most usefull, and likewise, he that hath some better knowledge, and can tell how to conclude these easie Questions, by other meanes, will sometimes use this Instrument for variety sake. I will now first draw the Figure, and then will propound some certayne Questions to make the Instruments uses appeare, as the worke following manifesteth.

Cut out both these Types, and place them upon the next
 Figure following, first *Sol*, and then *Luna*,

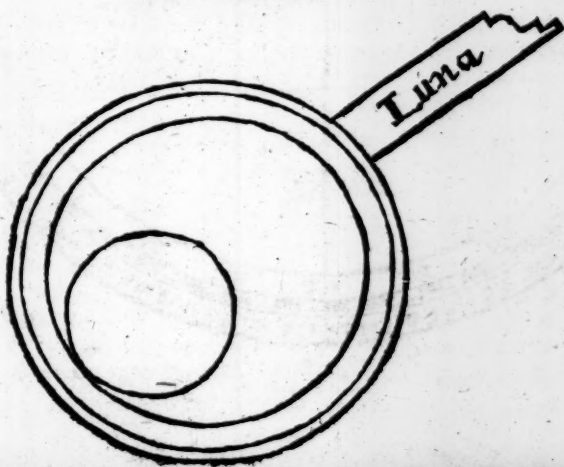
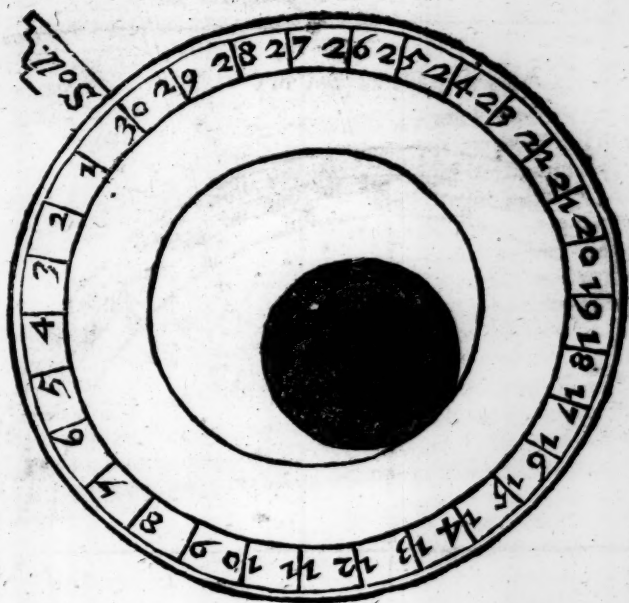
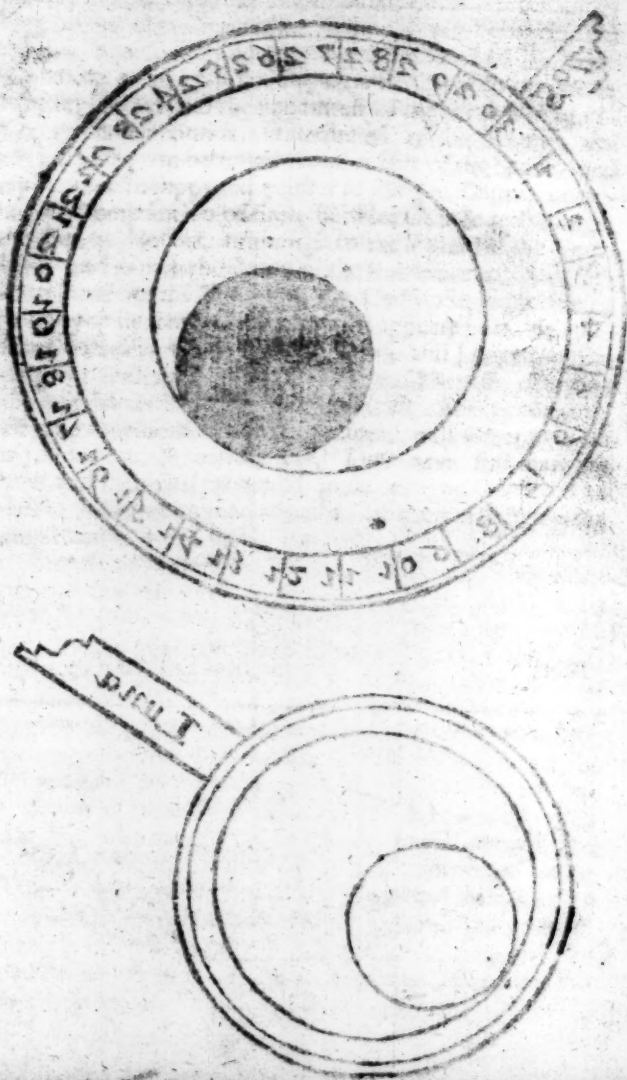
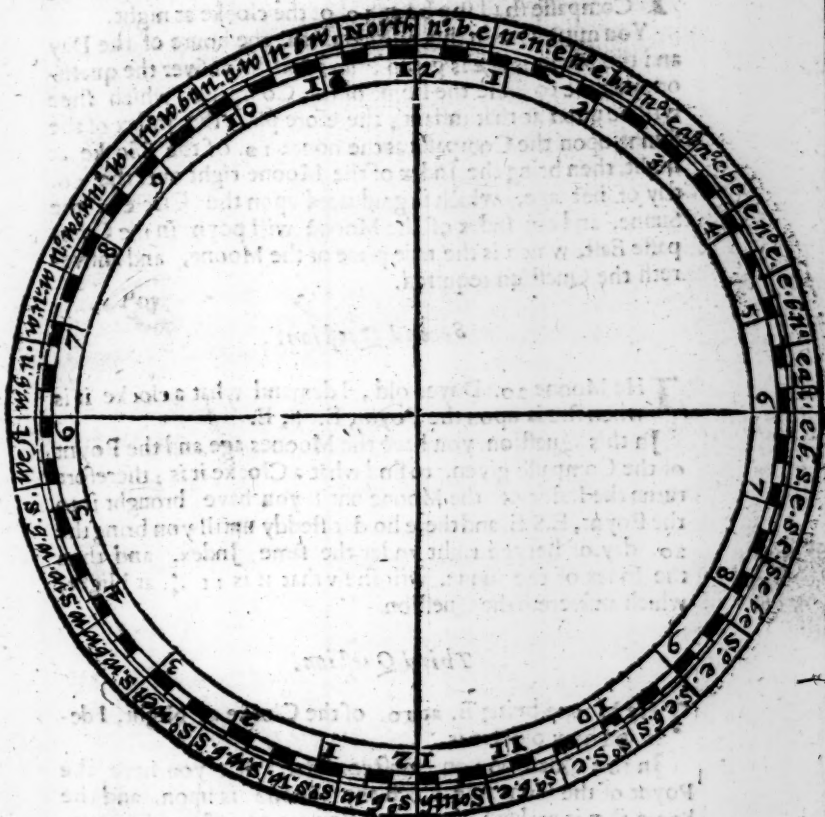


Figure following, and 2nd and then 1st.
 Cut out pecke Lyber, and place them upon the waxe



The Instrument or worke.



First Question.

THe Moone being 20. Dayes old, upon what Point of the Compasse shall she be at 10. of the clocke at night.

You must note in this question, that the houre of the Day and the Moones age is given, and that to answer the question, you are to finde the Point of the Compasse, which shee will be upon at that instant; therefore place the Index of the Sunne upon the Compasse at the houre 10. of the Clocke at night, then bring the Index of the Moone right over the 20. day of her age, which is graduated upon the Circle of the Sunne, and the Index of the Moone will poynt in the Compasse East, which is the true place of the Moone, and answereth the Question required.

Second Question.

THe Moone 20. Dayes old, I demand what a clocke it is when she is upon the Poynt, E. S. E.

In this Question, you have the Moones age and the Poynt of the Compasse given, to find what a Clocke it is; therefore turne the Index of the Moone untill you have brought it to the Poynt, E. S. E. and there hold it steady untill you bring the 20. day of her age right vnder the same Index, and then the Index of the Sunne, will shew that it is 11 . $\frac{1}{2}$. at Night, which answereth the Question.

Third Question.

THe Moone being E. at 10. of the Clocke at Night, I demand how old she is.

In this Question you must consider, that you have the Poynt of the Compasse which the Moone is upon, and the houre that it maketh given, but you are to answer the Question, by finding the Moones age; therefore bring the Index
of

of the Moone to the given poynt E. and then turne the Index of the Sunne, untill you bring it right with the houre given, which is 10. of the Clocke at Nighr, and then observe what day the Index of the Moone cutteth, and you shall find the 10. which is her age, and answereth the Question demanded with truth.

Fourth Question.

THe Sunne being West, and the Moone East, I demand what a Clocke it is, and how old she is.

In this Question, you have onely the Poynts of the Compassie given that the Sunne and Moone are upon therefore turne the Index of the Sunne due W. holding it steddy upon that Poynt, then bring the Index of the Moone to poynt due E. and you shall have vnder the Index of the Sunne in the Circle, containing 24. houres, 6. of the Clocke at night, and under the Index of the Moone, in the graduated Circle of her 30. dayes containned betwixt Change and Change, and you shall find 15. which is her age, and answereth the Question.

Fift Question.

THe Moone being 15 dayes old, I demand what a Clock it will be when she is upon the poynt, N.E.

In this Question you haue the poynt of the Compssie given, as likewise, the Moones age, and to answer the question, you are to give the houre, wherefore bring the Index of the Moone unto her poynt N.E. then holding it still, turne the Index of the Sunne, untill you have brought the 15th. day of her age, right under the Index of the Moone, and then the Index of the Sunne, will poynt right in the Circle of 24. houres to 3. of the Clocke in the afternoone, which answereth the Question.

Note alwayes, that if your Question be resolved, and that the Index which answereth the Question, poynt to the East-

ward of either N, or S, it sheweth the morning 12. houres; but if to the Westward of the N, or S. it sheweth the evening 12. houres.

Thus much I thinke will be sufficient to give any one of a reasonable understanding the full vse of this Instrument, which by often practising these and such like Questions, they will in short time be so ready in mind, that at the first propounding, you will be able to resolve them by memory, without any farther trouble, which will be a most excellent and profitable matter for the Practitioner of Navigation.

*How to find the time of Ebbing and Flowing
by this Instrument.*

YOU are alwayes to consider what Poynt of the Compasse the Moone is upon that day that it changeth, when it is full Sea in that River, Port, or Creeke which you are to find the Flood or Ebbe, which having found, you must consider, what houre belongeth to that Poynt of the Compasse, which by turning the Index of the Moone as before is shewed; you shall have the houre alwayes right under her Index, upon the day of her Change throughout all the Poynts of the Compasse, and now you must proceed to find full Sea in this manner; first turne the Index of the Moone, to the Poynt of the Compasse that upon her Change day maketh full Sea, in that Port, River, or Creeke, which you desire to know, and there holding it still, consider how old the Moone is, then turne the Index of the Sunne, untill you have brought the day of the Moones age right under her Index, and then the Index of the Sunne will answer the Question, and Poynt, right with the houre, as by these Examples will appeare.

First

First Question.

THe Moone 20. dayes old, at what a Clocke will it be full Sea at London-bridge.

Here you are to consider the Poynt of the Compasse that the Moone is upon when it is at full Sea upon her Change day, which in this Port is found by observation to be alwaies S. W. or N. E. (the opposite Poynt,) therefore observe, whether you would know the houre of the Day, or the houre of the Night, that is full Sea, if it be the houre of the Day, then bring the Index of the Moone to the S. W. Poynt, if of the Night, to the N. E. and there holding it still, turne the Index of the Sunne, untill you bring the 20. day of the Moones age right under her Index, and then the Index of the Sunne, will shew you in the Circle of 24. houres, 7. of the clocke in the Morning, or 7. of the clocke at Night, if you set the Index of the Moone to the Poynt N. E. then the Index of the Sunne will shew 7. of the clock in the afternoone, at which houre it is their full Sea when the Moone is 20. dayes old, which answereth the Question demanded.

Note alwayes, that the Moone betwixt change and full, is ever to the Eastward of the Sunne, still seperating her selfe from the Sunne, untill she be at the full, but after the full, in regard shee hath now performed more degrees in her separation, then is contained in a Semicircle, shee is gotten to the Westward off the Sunne, and now applyeth towards the Sunne againe, untill her change Day, which if you observe the Instrument, it doth plainly demonstrate.

Second Question.

THe Moone being 16. dayes old, I demand at what houre it will be full Sea at Weymouth.

In this Question, first consider what Moone maketh full Sea in that Port, which by experience is found to be East and

West; now therefore because the Moone is to the Westward of the Sunne, and is before the Sunne, being now 16. dayes old, you must bring the Index of the Moone to the poynt W. and there holding it, untill you have turned the Index of the Sunne, and brought the 16. day of the Moones age right vnder her Index, and then the Index of the Sunne will shew, that it will be three quarters past 6. in the Morning, when it is full Sea at that Port, the Moone being 16. dayes old.

Third Question.

THe Moone being 16. dayes old, I demand at what a clock it will be full Sea at *Dover* in the *Peetre*.

In this question, you must consider what Moone maketh full Sea upon the change Day, which is found to be N. and S; therefore I bring the Index of the Moone to the Poynt N. and there hold it untill I have brought the 16. day of the Moones age right under her Index, and then the Index of the Sunne will shew three quarters past 12. a clocke, which answereth the Question.

Fourth Question.

THe Moone 10. dayes old at what a clocke is it full Sea at the *Iland of Garnesey*.

Here at this *Iland*, a N. by E. Moone upon the change Day, maketh full Sea; therefore turne the Index of the Moone to the poynt N. by E. then turne the Index of the Sunne, untill you have brought the 10. day under the Moones Index, and then the Index of the Sunne, will shew that at three quarters past eight of the Clocke in the morning it will be full Sea, which answereth the Question.

Fift Question.

THe Moone 26 dayes old, at what a clocke will it be full Sea under *Bulloine* in *France*.

In this place, a N. E. by N. Moone upon the change day maketh full Sea; therefore bring the Moone to the point N, E. by N. and then turne the Sunnes *Index* untill 26. be right vnder the Moones *Index*, and then the *Index* of the Sunne will shew, that at three minutes past 11 of the clocke, it will be full Sea.

Sixt Question.

THe Moone 29 dayes old at *Amsterdam*, what houre maketh full Sea.

In this place a S. W. and N. E. Moone upon the change day maketh full Sea; therefore bring the Moones *index* to the poynt S. W. or N. E. and then bring the 29 day under her *index*, and the Sunnes *Index* will shew; that it is full Sea at a quarter past 2. of the clocke, which answereth the Question.

Thus I conclude, for finding the Flowing and Ebbing in all parts, by the ayd of this Instrument, and now I will in brieffe shew how to find the Moones age by *Arithmetick*, and how to account your Tydes, as likewise, to find the Prime Number, and the Epact, which are the principall matters to find the Moones age (and in short) the Motion of the Moone.

How to find the Prime Number and what it proceedeth from.

THe Prime Number is the space of 19 yeares, in which time the Moone performeth all her Motions with the Sunne, at the expiration of which terme she beginneth againe in the same signe of the *Zodiacke*, that she was 19, yeares before, and alwayes finisheth her whole course with the

the Sunne, in that terme, which she never exceedeth, so that if I have a desire to know any thing concerning the Moones age, or her motions in the Heavens, that she hath made many yeares past or (to come) onely by the helpe of Addition and Subtraction you may be resolved with as much certainty, as if it were any thing in present: but to proceed for the finding of this Number so usefull, you must alwayes take this course. In that yeare of our Lord, which you would know, what is the Prime Number, (adde one to) and then divide it by 19, and that, which remaineth upon the division, and cometh not into the quotient, is the Number required; as for Example, in the yeare of our Lord, 1631. I demand, what is the Prime Number, now therefore if you adde one, to the aforesaid yeare, and divide the of-come by 19. there will remaine upon the division, that cometh not into the quotient 17. which I say is the Prime Number, and for this matter being so easie, I need not use more demonstrations, onely you are to observe, when you find nothing remaining upon the division, that is the last yeare of the Moones Revolution; and therefore may conclude, that 9 is the Prime for that yeare, and you must also note, that the Prime alwayes beginneth in January.

How to find the Epact, and what it willeth to shew
 proceedeth from the motions of the Moone

THE Epact is a Number that proceedeth from the difference which is made in the space of one whole yeare, in accompting the Moones tearme, and the Sunnes, for the Solar yeare doth containe neerer 365. dayes, 8. houres 48. min. and the Lunar yeare doth containe after the rate of allowing her 30. dayes betwixt Change and Change, 360. dayes but 11. houres and 16. minutes, which in the terme of each 30. dayes must be frustrated, because 30. dayes, is so much more then in truth is contained, which in the terme of 12. Moneths, amounteth to 5. dayes, 15. hou. and 16. min. and the Lunar yeare wanteth of the Solar, 5. dayes, 8. hou. 48. min. neerer

nearest; both which summes being added together, will make 11. dayes; and now to proceed to find the Epact, doe in this wise multiply the Prime Number for the years, by the differences of the Solar and Lunar years, which I have shewed to be 11. dayes, and then divide the product by 30. dayes, and that which remaineth upon the division, and cometh not into the quotient is the Epact, as for Example, In the former year, 1631. where I shewed you to find the Prime Number, which appeared to be 17. Now therefore if you multiply 17. by 11. it will make 187. which being divided by 30. there will remaine upon the division, that cometh not into the quotient 7. which is the Epact for that yeare, and this is sufficient to be expressed in so facill a matter; onely you are ever to note, that the Epact beginneth in *March*, by these examples, I make no question but you understand the reason of the Prime, and Epact, as likewise how to find them in any yeare that you desire but in regard those which are unacquainted with Arithmaricke, are debar'd from the way of these two most necessary Numbers, I will make a small Table for 40. yeares yet to come, wherein any one shall most easily find the Prime and Epact for any yeare that he shall desire; but in the first place, I will shew the use and operation of these two Numbers, in finding the Moones age and the shifting of Tides.

How to find the Moones Age at any time

HAVING attained to the finding of the Prime and Epact you may find the Moones age at any time desired, in this manner, first consider the Moonth and day of the Moonth that you desire to find her age, and then reckon how many Moonths are contained betwixt your present moonth, and the moonth of *March* including both those moonths, in your Number, then add the Epact for that yeare, and all those summes being added together, is the Moones age, if it exceed

not 30. which if it doth, you must cast away 30. so often as you can, and then the remainyng is her age; as for Example, in this present yeare of our Lord 1624. the Prime Number is 1. and the Epact is 11. now I demand, what age the Moone is of, the 24th day of July, from March to July, is 9. months, (including both Moneths) which being added to 24. the day of the Moneth maketh 39. and then adjoyne the Epact, it will make 40. therefore casting away 30. there will remaine 10. which is the age of the Moone, and answereth the Question.

How to find when it is full Sea in any Port, Creeke, or River.

HAVING shewed you formerly how to find the Prime Epact, and age of the Moone, at any time desired, you may proceed for the finding of full Sea in any place in this manner; first you must consider, as afore is shewed, what poynt of the Compass the Moone is upon on her change day, when it is full Sea in that Port which you desire to know, and likewise what houre is proper for that poynt, which having considered, as likewise, how old the Moone is, you may by Arithmetick instantly resolve, the Moones age being multiplied, by 4. and the ocome divided by 5. adde the houre proper to the Poynt of the Compass the Moone is upon, in her time of Change, if there remaine any thing upon the division that cometh not into the Quotient, for every one that remaineth you must adde 12. minutes, for 2. 24. minutes, for 3. 36. minutes, for 4. 48. minutes, and more then foure you shall never have upon your division; by a few Examples, the manner of worke will appeare most easie and plaine, which of purpose, I will now take those 6. Questions, which formerly I did resolve by the Instrument, that the worke may appeare more plaine and certaine, to those which are acquainted, and less worke by them both, and the truth of the Instrument will be more plaine, by comparing both together, as for example,

First

First Question.

THe Moone 20. Dayes old; at what a Clocke is it full Sea at London-bridge.

Here you must consider the poynt of the Compasse that maketh full Sea upon the Change day, which is found to be S. W. and N. E. and the houre proper, to that poynt is 3, therefore J proceed and multiply 20. the Moones age, by 4. and it maketh 80. which I divide by 5. and there commeth 16 into the quotient, which is houres, and nothing remaineth upon the division; therefore, I onely adde 3. to 16. and it maketh 19. which because it exceedeth 12. J cast away 12. as often as J can, and there remaineth 7. which is the time of full Sea. and answereth the houre demanded, you must ever note, that if the generall summe exceed 12. you must take 12 so often as you can out of it, and the remainder will answer the Question most certainly.

Second Question.

THe Moone is 16 dayes old, at what a clocke will it be full Sea at Weymouth.

Here at this Port upon change day, an E. and W. Moone maketh full Sea; therefore you must multiply 16. the Moones age by 4. and it will make 64. which being divided by 50. there commeth into the quotient 12. houres, and there remaineth upon the division 4. which as hath beene formerly shewed, signifieth 48. minutes; therefore adjoyning those 48. minutes unto 12. houres, it appeareth most plaine that at the aforesaid Port, it will be full Sea at 48. minutes past 12 of the clocke, which answereth the question.

Third Question.

THe Moone being 10. dayes old, at what a clocke is it full Sea at the Iland of Garnesey.

Here at this Port upon Change day, a N. by E. Moone maketh a full Sea; therefore I multiply 10. dayes being the Moones age by 4. and it maketh 40. which summe I divide by 3. and there cometh into the Quotient 8. houres, and nothing remaineth upon the division, therefore you must onely adjoyne the houre proper to the poynt, and the question is answered, which upon this poynt of N. by E. is 12. houres, 48. minutes; therefore I omit the 12. houres, and onely adde the 48. minutes, so that it appeareth at 8. of the Clocke, and 48. minutes past, it will be full Sea, in the aforesaid Port.

Fourth Question.

THe Moone 16. dayes old, at what a Clocke is it full Sea at Dover in the Peere.

In this place, a N. and S. Moone; therefore worke as afore hath beene shewed, and you will find it, at 48. minutes past 12. a Clocke.

Fifth Question.

THe Moone 26. dayes old, at what a clocke is it full Sea at Bulloyn in France.

Answer; a N. E. by N. Moone; therefore at 1. a clocke and 1. minutes past.

Sixth Question.

THe Moone 29. dayes old, at what a Clocke is it full Sea at Amsterdam. Here a S. W. and N. E. Moone; therefore at 2. houres and 12. minutes.

Hereafter followeth the Table for the Prime and Epact, Calculated for 40. yeares yet to come from this present yeare 1634. the table is so plain, it cannot chuse but be understood by any at the first sight.

Of the Moones Motion, and the proportion of Time
betwixt Tide and Tide.

HAVING formerly shewed the severall wayes how to find the Moones age, first by the helpe of Instrument, and then Arithmetically, by getting the Prime Number, and Exact, for the yeare of our Lord; having which, you are able to find the time of full Sea in any Port you desire, I will now shew you in briebe, the Motions of the Moone, and the reason of the difference of time betwixt Tyde and Tyde, the Motions of the Moone are two-fold, first, a violent motion, which is from E. to W. caused through the Diurnal swiftnesse of (*Primum mobile*;) secondly, a naturall motion, from W. to E. in which motion the Moone doth require 27. dayes and 8. houres, to come to the same minute of the Zodiacke, from whence she departed, but coming to the same Place where she was in Conjunction with the Sunne last, she doth not find him there againe, in regard the Sunnes naturall Motion is every day one degree or 60. minutes E. which maketh so much difference, that the Moone must performe two dayes, 4. houres, and 36. minutes neerer more then her naturall motion, before she can fetch up the Sunne to come into conjunction with her, so that betwixt Change and Change, is 25. dayes 12. houres and 36. minutes, by my account, but the Sea-men, doth allow just 30. dayes, betwixt change and Change, in regard he will not be troubled with small fractions of time, in his account of Tydes, which bringeth no great error; therefore Experience being my best authority in this poynt, I will likewise give the same proportion, allowing the Moone in every 24. houres to depart from the Sunne 2. degrees, or 48. minutes of time, which is untill her full E. but then having performed in her naturall motion, about the quantity of a Semicircle, she is then to the West, as reason expresseth. Now if the Moone move in 24. houres 48. min. then in 12. houres; she must move 24. minutes, and in 6.

houres, 12. minutes, by this proportion, each houre she mo-
veth 2. minutes, and as the difference of time is, so is the dif-
ference of Tydes.

*A Table shewing the Prime and Epact for 40. yeares
yet to come.*

The y of our Lord.	Prime.	Epact.	Yeare of our Lord.	Prime.	Epact.	Yeare of our Lord.	Prime.	Epact.	Yeare of our Lord.	Prime.	Epact.
1634	1	11	1644	11	1	1654	2	12	1664	12	12
1635	2	22	1645	12	12	1655	3	3	1665	13	23
1636	3	3	1646	13	23	1656	4	14	1666	14	4
1637	4	14	1647	14	4	1657	5	25	1667	15	15
1638	5	25	1648	15	15	1658	6	6	1668	16	26
1639	6	6	1649	16	26	1659	7	17	1669	17	7
1640	7	17	1650	17	7	1660	8	28	1670	18	28
1641	8	28	1651	18	18	1661	9	9	1671	19	29
1642	9	9	1652	19	29	1662	10	20	1672	1	11
1643	10	20	1653	1	11	1663	11	31	1673	2	22

Of the Globe.

After that the young Practitioner of Navigation hath at-
tained to perfect knowledge of all the points of his
Compass, and that he is well acquainted with the shifting of
all manner of Tydes, the next principall, respect most proper-
ly upon the terrestriall Globe, where all manner of distances
are to be measured, which cannot be attained unto, without the
knowledge of the nature and quality of many severall Circles
which gird the whole body; therefore I will briefly define
them, and shew reasons in the matters of most Importance.

Of the Ball of the Globe.

First, the Ball or round body in his upper superficies, doth easily demonstrate unto us the Hidregraphically description of the Sea, and the Geographical description of the Land; this Superficial knowledge, the weakest Capacity discerneth as the first sight, for by the description of the Seas and Lands, it appeareth which is Sea, and which is Land, and then that both of them joyntly together make one round body is most evident.

But this knowledge proceeding not from reason, and the rules of Art, is as farre from perfection as the (*Chaar*) was before it pleased the divine Creator, to separate the confused mixture of the Elements into their proper places; for now you behold a body of an exact round forme, but are not able to measure any part of him, neither know how it is Scituated, in respect of the Spheares which turne round about him; now then it is most necessarie for us to set this round body in his proper place, and then to divide him with Circles according to Art, whereby we may gaine the knowledge of each severall places, distance from each other, as likewise how they are Scituated, in respect of the motions of the Sunne and Starres.

First, then I place the whole Globe, according to my conceived apprehension to be even Scituated in the very center, and that this whole body in respect of the Heavens hath in all respects, the same resemblance that a small poynt or pricke being the center of a large circle (hath to his circumference;) the Globe being thus placed, it is most facill to conceive that a perpendicular line falling from the Heavens, and running through the Globe or Center, to the opposite part of the Heavens, can be but in two certaine poynts, which two poynts we terme or call the Poles of the World, expressed by the denominations, of Arcticke and Antarticke, and the Perpendicular, we call by the name of the Axeltree; here
came

cause upon the period of their extreames, wee suppose the Sphaeres are turnd about by the force of (*Primum mobile*) or the first mover, the terrestiall Globe being thus Scituated in your imagination, with this Axeltree running directly through him, may now be girt with his severall circles, where by evident and infallible conclusions, wee are able by plaine demonstrations to give all manner of distances, as likewise the content of the whole Body.

Of the Equinoctiall.

THe first Circle, as the foundation for all the rest which I will describe upon the terrestiall Globe is the Equinoctiall, which must be extended from E. to W. leaving both the aforesaid Poles of one equal distance, from all parts of the whole Circle, this Equinoctiall Circle is divided into 360 deg. and importeth by his denomination his nature & quality, by two distinct operations: First, in dividing the whole World into two equal parts, allowing the one halfe of the Terrestiall Globe, to appertaine unto the North or Arctike Pole, and the other to the South or Antarticke Pole; Secondly, alwayes when the Sun by his yearly motion Intersecteth the Equinoctiall points, the dayes and nights are of one equal length in all parts of the VVorld, and so the denomination of the word is probable to come from the Latin (*Equus dies & noctis*), and now the Globe being onely circled with the Equinoctiall, the foundation of measuring is laid, but small use can be drawne from this foundation, untill we raise some other buildings which will shew his use by the effects.

Of the Meridian.

THe Terrestiall Globe having as yet but one onely Circle namely the Equinoctiall, which divideth the world into two equal parts, I find it most Convenient to describe another circle of the same magnitude, though of a severall nature

ture, namely the Meridian, this Circle runneth directly North and South, even through the imagined poynts which wee terme the Poles; and intersecteth the Equinoctiall, at right Angles: so the Globe is Quartered into foure equall parts, which the meanest capacity cannot chuse but conceive, now by the ayde of these two Circles, we are able to measure all parts or portions of all other Circles, that are extended betwixt any two places upon the Terrestiall Globe; as likewise to give the whole content of the circumference, in any kind of measure that shall be required: The certaine truth of our measuring, is groundel upon taking the Altitude or height of some knowne body Scituated in the Heavens, for by such an observation, wee conclude an infalliable certainty as by a short demonstration shall appeare.

As for Example; Suppose I am neere in *London*, a place well knowne by divers heedfull observations, to be Scituated in the Latitude or bredth from the Equinoctiall 51. degrees 32. min. Imagine, that J take any certaine number of any sort of measure, directing my course dew South, untill J find by the Starres or Sunne, that I have altered my Latitude or bredth one degree, which by experimentall conclusions is found, must needs bee sixty English Myles or twentie English Leagues, before J can have any such alteration: Now then J conclude, if J must goe 60. English Myles or 20. Leagues, due South, before the North Starre will be one degree lower then it was; That if J were under the Pole, where I should have the North Starre in my Zenith, J must needs goe or Saile 90. degrees, before J come to bring the Equinoctiall in my Zenith, and the Starre in my Horizon; for betwixt the Pole and Equinoctiall is a Quadrat, or fourth part of a Circle, as before I have shewed. Now then by the rule or proportion, (or reason) if one degree of the Meridian require 20. Leagues, or 60. Myles, 90. the of same degrees, will require 1800. Leagues, or 5400. Myles, which is one quarter of the Globes circumference, and then it is most apparent, that the whole terrestiall Globe is but foure times as much, which

is 7200. English Leagues, or 21600. Myles, and so much is the whole circumference in the Equinoctiall or Meridian, and now againe, if one degree containe 20. Leagues, or 60. Myles, then 7200. Leagues, or 21600. Myles, will containe in the same proportion 360. degrees, which is likewise the whole circumference of the Terrestiall Globe in degrees, and the fourth part of those degrees must needs bee 90. degrees, so that by this demonstration, it appeareth there can be no doubt of the certainty of our measuring. Now then, these two Circles of one magnitude, namely the Equinoctiall and Meridian, being exactly divided into 360. equall parts or degrees, as you shall ever find them upon the Terrestiall Globe, maketh all kind of distances betwixt any places assigned, most facill to be measured, for if you take the distance of any two places with your Quadrant, which is onely a thin plate of Brasse, containing the exact fourth part of degrees, either of the Equinoctiall or Meridian, you will see what quantity of degrees are contained betwixt them, which may soon be turned either into Leagues or Myles, by allowing for each degree 20. Leagues or 60. Myles as hath beene manifested before, these two Circles thus divided and described, and with certaine and infallible truth proved by the former demonstration, is sufficient to satisfie any man for the measuring of all sorts of distances, upon the Terrestiall Globe, and the way of measuring is so plain, that it is not common sence, should find any difficulty; but yet you must understand, that although I have mentioned but one Meridian upon the Terrestiall Globe, yet you shall finde divers Meridians described upon all Globes, yet but one that is graduated or divided into degrees, which serveth as well as if they were all divided, for they are of one nature and quality, and intersect each other in the very poynts which wee call the Poles, and all of them cut the Equinoctiall at right Angles.

The Meridian thus described discovereth most evidently the falseness of the Cards or Plats, which are projected in

Plans:

Plano : for there you shall find divers Meridians likewise described, (namely all North and South lines) with one graduated Meridian as in the Globe, but you will finde them all parallels to each other in all Latitudes or breadths, even to the very Poles, where according to the Globe they should intersect each other, so that when the foundation is false, you may well consider, what dangerous errors those runne into, which allow the Card or Platt, because most easie, most excellent for Navigation.

I have sufficiently defined these two Circles, by the ayd of which, as hath beene expressed, all manner of distances may bee resolved. Yet there remaineth divers Circles which must be understood, or you will understand the nature and quality of the Globe but in part.

Of the Ecliptick.

THe Eclipticke is a Circle of the same magnitude of this Meridian, and intersecteth the Equinoctiall at two certaine poynts which divideth it into two equall parts, but not at right Angles, as the Meridian, but with Accute or Sharpe Angles, and so the greatest Arches of the Eclipticke, cannot be distant from the Equinoctiall above twenty three degrees and thirty minutes, which 23 degrees 20 min is likewise the quantity of the Angle, which is ingendred by their Intersections, the chiefe use of this Circle, is to demonstrate unto us the yearely motion of the Sunne, through the 12. Signes of the Zodiack; this Circle is divided into 360. degrees, shewing the daily motion of the Sunne, and these 360. degrees are distributed amongst the 12. Signes in a proportionable manner, namely to each Signe 30. degrees, so that according to the Sunnes dayly declination, wee are able to shew the degree and minute of the Ecliptick, where shée Intersecteth, which taketh his name according to the denomination of the Signe, by the knowledge of which, wee conclude the degree and minnte of the

Sunnes declination or distance, from the Equinoctiall, which is the chiefe director in finding how any place is Scituated upon the Terrestiall Globe, in respect either of the Equinoctiall or Poles; for though in a vulgar phrase, it is commonly termed the Altitude or height of the place, where wee observe the Sunne or Starres, with our Geometricall Quadrant, Astrolab, Crosse-staffe, or such like Mathematicall Instruments, Yet I say the bare height of any body Scituated in the Heavens (which each one of the meanest Capacity, is able at the first demonstration to resolve) is of no consequence to discover the Latitude or breadth of that place, either from the Pole or Equinoctiall, except you are able at time of observation, to give the true declination of the body which you observe, and then indeed you may conclude an infallible certainty, namely how many degrees and minutes your place of being is both from the Equinoctiall and Poles.

Of the Colures.

THe Colures are onely two Meridians, which are, as it were bounds or markes, shewing what degree of the Eclipticke the Sunne intersecteth, when shee maketh her greatest North and South declination, as likewise, where and in what Signe shee intersecteth the Equinoctiall, where shee hath no declination, these intersections of the Colures, plainly demonstrateth unto us, the division of the foure quarters of each Yeare; and when they begin and succeed each other, as namely the Colure which intersecteth the Equinoctiall and Ecliptick, (where they likewise intersect each other) is called the Equinoctiall Colure, and sheweth that the Sunne hath no declination, from which intersection, wee have the denomination of two of the same Yearely quarters, for if the Sunne be in the last minute of *Pisces*, or entring into the first minute of *Aries*, it sheweth the first of our Spring, and that the Sunne hath passed that Equinoctiall Poynt, and is making her North declination, whose glorious presence as much reviveth both Man,
Beasts,

Beasts, and Plants, Scituated towards the Arttick Pole, as he absence maketh them droope towards the Antartick, and this interfection is ever neere the 10th. day of *March*, but if the Sunne be in the first minute of *Libra*, or the last of *Virgo*, when shee interfecteth the Equinoctiall, our Arttick Pole mourneth for the Sunnes ensuing absence, and the Antartick rejoyceth for her approaching presence; this Equinoctiall poynt, sheweth the beginning of our Winter, and their Summer, which are Scituated to the South or Antartick, which ever happeneth neare the 11. day of *September*.

The other Colure, is called the Solsticiall Colure; because the Sunne having now his greatest declination, is not to be discerned for two or three dayes, to have any sensible alteration: This Colure interfecteth the Ecliptick in his greatest Arches, on either side of the Equinoctiall, by which interfections; the two other quarters of our Year are expressed, as namely, if the Sunne be in the last minute of *Gemin*, or entering into the first minute of *Cancer*, it sheweth that the Sunne hath now her greatest North declination, and that now when she interfecteth her Meridian at Noone, she hath the greatest Altitude above the Horizon, to all places Scituated towards our Arttick Pole that is possible; for her to have, which is the cause that now wee have our longest Dayes and shortest Nights, and now beginneth our Autumne or Harvest, and this interfection happeneth ever neare the 16th. day of *June*, but if the Sunne be in the last minute of *Sagitaris*, or entering into the first minute of *Capricorne*, it sheweth the Sunne hath now her greatest South declination, and is of the least Altitude above the Horizon, when she interfecteth the Meridian at Noone, to all that are Scituated towards our Arttick pole, that she ever possible may be; which causeth our shortest Day and longest Night, that is the dead of our Winter, and the beginning of Autumne or Harvest, to all those which are Scituated towards the South or Antartick Pole, this interfection ever happeneth neare the 12. th day of *December*.

Of the Rombe.

THE Rombes or Courfes, are all Circles of the greatest Magnitude, onely when the Equinoctiall is in your Zenith, but if otherwise, then I say they are Circles, bearing proportion with the Parallel where you are, as this plain and easie demonstrations will manifest.

Suppose that according to headfull obfervation, our place of being were right vnder the Equinoctiall Line, and that then we should take any notice only of the 32. poynts of our Compasse, according to each severall Rombe of E. and W. and then doe but confider that our place of being is in the very interfection of the Geographickall Equinoctiall, which is described upon all Terrestiall Globes; reason resolvethe the matter, for as that Circle of the greatest magnitude, is produced through the extreame extension of E. and W. so the Rombe of E. and W. shewed by the Compasse, must needs according to his greatest extension, be of the same magnitude, and then likewise, if you observe your N. and S. Rombe, you will with the like facility perceive, that it interfecteth the Equinoctiall or your E. and W. Rombe at right Angles, and therefore in that place, must be a Circle according to his greatest extreame of the same Magnitude with the Meridian: And then it followeth most plaine, that all the other Rombes running through the aforesaid Interfection, must now bee Circles of the greatest magnitude in their extreame extensions.

But if you observe the Rombes by your Compasse in any Paralell or Latitude, there will appeare but one Rombe or course that will be a Circle of the greatest magnitude, namely your N. and S. course, which is alwayes your true Meridian (if the Compasse have no variation) and therefore according to his extreame extension is a Circle of the greatest Magnitude; but now your E. and W. Rombe will not hold proportion with the Meridian, because all Paralels are lesse then the Equi-

Equinoctiall, and therefore now all the rest of your courtes or Rombes besides your N. and S. courle, are Circles according to their greatest extreames of a lesser magnitude; as for Example, suppose wee are in the Latitude or Paralell of 60. degrees from the Equinoctiall, and now observe the E. and W. and N. and S. Rombs by your Compass, we shall find they intersect each other at right Angles, but wee must not conclude as before, that according to their extreame extentions, they are both Circles of the greatest magnitude; for here in this place, the Globe plainly demonstrateth unto us, that the E. and W. Rombe or Paralell in his greatest extreame, is but halfe so bigge as the Equinoctiall; therefore all the rest of the Rombes or courtes, except the N. and S. Rombe, must hold the same proportion. I would have the Practitioner of Navigation to discusse most diligently upon the aforesaid demonstrations, which are most easie, and will prove most excellent for producing the reall truth of many matters in Navigation, as by divers future conclusions will bee manifested.

Of the Tropicks.

THese two Circles are of one Magnitude, and are Paralels to the Equinoctiall intersecting the Solstitiall Colure, at the Latitude or bredth of 23 deg. 30 minutes, and these two Circles represent the utmost bounds of the Sunnes declination, on either side the Line; and are Touch-lines to the great Arches of the Eclipticke in two certaine Signes, from whence they take their severall denominations, namely our Northerne Tropicke, toucheth the Eclipticke in the first minute of *Cancer*, and therefore is called the Tropicke of *Cancer*, and the Southerne Tropicke, toucheth the Ecliptick in the first minute of *Capricorne*, and is likewise called the Tropicke of *Capricorne*, betweene these two Tropicks, and under the Equinoctiall, round about the whole circumference of the terrestiall Globe from East to West, is Scituated that Zone which formerly hath beene termed (*Torrida Zona*)

or

or the burning Zone, for in any place betwixt the two Tropicks, or within 23. deg. 30. min. of the Equinoſtiall, you ſhall have the Sunne twice each yeare in your Zenith or Perpendicular, right over your head, at which time it hath beene the opinion of many great Philoſophers, that the powerfull influence of the Sunnes bright beames being extended right downwards, the heate occasioned by their reverberation was insufferable, which indeed according to humane reason doth appeare very probable, and I am ſtill of their opinions though I have beene divers times for many Moneths together, ſaying within the Torrid Zone, in moſt temperate weather, when the Sunne hath beene according to our Courſe conſtantly right over our heads, or very neere our Zenith poynt.

But this temperatenesse is occasioned by a Supernaturall operation, which the Divine Creator in his great Providence hath provided as a remedy to qualifie the parching heate of the Sunne beames, namely a certayne breeſe or gale of wind, which ever bloweth betwixt the N. and E. in thoſe parts. And it is worthy of obſervation to behold the great goodneſſe of our Maker, that hath appoynted this remedy daily to riſe with the Sunne, whoſe powerfull beames would ſo much annoy the Inhabitants, and ever as the Sunne riſeth above the Horizon by degrees, untill ſhe come to her Meridian or greateſt Altitude, ſo the breeſe of wind commeth by degrees ever increaſing and blowing more freſhly as the Sunne riſeth, ſo that when the Sunne is at higheſt the breeſe ever bloweth moſt freſhly; and ſo decreaſeth againe as the Sunne groweth lower untill ſhe be ſet under the Horizon, and then the breeſe is likewiſe done. And now yeeldeth as much benefit to Mortall man by ceaſing to blow in the Night as it did profit him in qualifying the heate of the Day: For if it ſhould blow as freſhly in the Night time, as it doth in the heate of the Day, when the powerfull beames of the Sunne is qualified, it appeareth in common reason, that if the Sunne were wholly abſent, and that the coole wind ſhould ſtill
con-

continue, the Inhabitants would be very sensible of such a suddaine alteration, and feele it most extreame cold, and so would breed a great distemperature in theyr bodyes; but the generall calmes in the Night, when the Sunne is wholly absent answereth a proportionable temper. And so we must onely praise our Maker for his benefits, and not strive to render reason for Supernaturall matters, onely we may presume in way of comparison, that as it hath pleased the great GOD to provide remedy beyond our reason, for the Parching heate, that he hath likewise provided some supernaturall meanes, for (*Frigida Zona*) or the Frozen Zone, that it may be Inhabited (as I make no question but it is,) although in our reason, the influence of the Sunnes beames, are of so small power in the Regions Scituated neare unto either of the Poles, that they can yeeld little comfort, either to Man, Beast, or Plants; and againe, the Sunne ever being absent and never seens above their Horizon, at either of the Poles, for sixe Moneths together, when the Equinoctiall is betwixt them, and the distance where she maketh her motion, which exceedeth above a Quadrat or quarter of the Meridian, and therefore not to be discerned! Yet I say for all this, it may be Inhabitable, as no question but future times will discover both it and greater matters, that as yet remaine wrapt in obscure clouds neere unto the Poles.

Of the Paralels.

Vpon the Terrestiall Globe there may bee described infinite Circles from East to West, betwixt the Equinoctiall and Poles which will be Paralels to each other, but no Circles described from North to South can be Paralels, because theyr Meridians Intersect each other in the points, termed the Poles; these paralell Circles described from East to West, have all of them one Center from whence they are described, namely the poles, and from that Center there can bee but one Circle described of the same magnitude with the
G Meridian

Meridian, which is the Equinoctiall, all other Circular Paralells are of lesse Magnitude ever decreasing as they are described nearer to eyther of the Poles, so that at the Latitude of 60. Degrees, that circular Paralell is but halfe so bigge as the Equinoctiall, and circular Paralell situated neerer; the poles are still of lesse Magnitude untill you come to the very Center our Pole, where it is not capable of any thing being onely a poynt.

The want of due consideration, what proportion each severall Paralell, in each severall Latitude beareth in respect eyther of the Equinoctiall or Meridian, is the cause the Navigators of these dayes produce such lame and imperfect Conclusions, as many times by Experience I have found, that in running 8. or 9. hundred Leagues, and raising the Pole not above 12. Degrees, the chiefe men in generall which were in our Ship have beene short in the true Longitude, when wee were in the height or Latitude of the place neere upon 100. Leagues, which Error I plainly Demonstrated, proceeded onely for want of knowledge of the proportions of each severall Paralell; but because those proportions were beyond theyr Capacities to finde out, they would have all Concluded, wee had made more way with the Ship then was accounted of, and so would have cloaked a most grosse Error with a generall mistake, but my reckoning being different from them all and pointing with the truth, I would not allow of theyr Conclusions, but by playne Demonstration most easie for any of them to conceive, I shewed the falseness of all Cards in *plano*: (which have all equal Degrees in the Meridian) and what lame Conclusions must be expected from those which in long Voyages put theyr trust in them, the Demonstration which I produced was taken out of that worthy Author, Mr. *Edward Wright*, who hath so excellently Corrected and detected the Errors of Navigation.

Suppose two Ships sayling right under the Equinoctiall Line, and it were certainly knowne, that they were East and West from each other the exact quantity of 100. Leagues. I demand

demand if those two Ships should now saile both of them due North untill the Pole were Elevated 60. degrees, how many Leagues would these two Ships bee from each other.

According to your Cards in *Plans* which maketh all Meridians to be paralells, and all Paralells of the same Magnitude with the Equinoctiall, apply your Compasses, and you will find even 100. Leagues, the same distance as at the Equinoctiall, then which there is nothing more contrary to truth; For all Meridians according to the Sphearicall body of the Globe must intersecting the Equinoctiall at right Angles, and distant from each other at those two Intersections 100. Leagues must needs at the Latitude of 60. degrees where the Circular Paralell is but halfe the Magnitude of the Equinoctiall, and so to conclude with truth, these two Ships are now but 50. Leagues distant from each other. The due proportion that all Paralells have to the Equinoctiall and Meridian in all Latitudes is too curious a worke, for many men to performe; yet for the love which I beare in generall to all the Practizers of this Art, I have with the expence of a great deale of paines already calculated two small Tables which will appeare in the ensuing worke, whereby the meanest Mariner shall bee able at first sight to resolve the proportion of all Paralells, in respect of the Equinoctiall and Meridian; as likewise the differences of their Longitudes both in Leagues, Myles, and Paces, thus much of the Terrestiall Globe, with all manner of Circles described upon him, which if they be judiciously observed, is as much as is possible to be demonstrated, and will sufficiently satisfie any reasonable capacity for the full understanding of the whole Terrestiall Globe in all his particular Circles of severall qualities.

Of Latitude.

Latitude importeth as much as breadth, being alwaies that Portion of the Meridian which is contained betwixt two Parallels, the Equinoctiall being ever one, and your point being the other; for if a Parallel were extended from the Poynt of your being untill it made a whole Circle, and joyned again in your first poynt, you might ranne all the degrees of that Circles Longitude untill you arrive againe at the first poynt: And never alter one minute of your first Latitude.

Of finding the Latitude.

After the Practitioner of Navigation, hath thoroughly understood all the Principles, which are afore-mentioned, I hold it convenient that he should now use his endeavour to take the Altitude of bodyes scituared in the Heavens, as (Sunne and Starres) by which Altitudes, he shall most facilly find the Latitude or breadth which he is in, for the handling of your Geometricall Quadrant, Astrolab, Crosse-staffe, or such like instruments, in time of observation is so facill, that at the first sight Common sense cannot but conceive it; therefore I will of purpose omit that matter, and proceed to the manner of worke after the Altitude is gained. Now then to attaine this Latitude or portion of the Meridian contained betwixt your Parallel and the Equinoctiall, you must be very circumspect in observing these three things: First, the Altitude of the Sunne according to the side of the Angle given by your Geometricall Instrument: Secondly, that you know the declination of the Sunne for that day, when she intersecteth the Meridian: Thirdly, that you have a speciall care to consider the scituation of your Zenith Poynt, in regard of the body observed (of which Poynt) it must alwaies (if you have Latitude) be found in one of these three respects; first, either the

the Sunne is betwixt your Zenith, and the Equinoctiall, or else the Equinoctiall is betwixt the Sun and your Zenith; or Thirdly, your Zenith is betwixt the Sunne and the Equinoctiall. Now these three different situations of your Zeniths maketh three severall sorts of working to find the Latitude, after you have observed the Altitude, which by Examples of each severall situation I will heere make plaine, with the manner of worke, very easie to be understood by the meanest Capacity, if he will but take some small paines to conceive the reason of the worke, produced by Zenith distance and declination rightly applied.

First Question.

Demand. how J shall give the Latitude here at *London* the 11th, day of *June*, according to the Altitude of the Sun observed.

Here J consider by my Ephemerides, or by the common Tables calculated, that the Sunne hath to day 23. degrees, 30. minutes North declination, when she is due South or upon her Meridian.

Then J consider the situation of my Zenith poynt, and I find that the Sunne is betwixt it and the Equinoctiall.

Wherefore now J take my Geometricall Instrument, when I find the Sunne almost South, or upon her Meridian, and continue observing untill I have her at the greatest Altitude which here admit I find, is 61. deg. 58. minutes, which Altitude I Subtract from 90. deg. 00. min. and have remaining 28. deg. two min. therefore J conclude, that is the distance of the Sunne to day from my Zenith Poynt. And in regard I find the Sunne hath to day North declination, and that my Zenith poynt is situated, containing the Sunne betwixt it and the Equinoctiall, J joyne my declination and my Zenith distance from the Sunne into one summe, which J say is the true Latitude or breadth of *London* from the Equinoctiall.

Man-

Manner of worke.

The quantity of your Quadrant, is alwayes — $\begin{array}{r} \text{deg. min.} \\ 90 \text{ — } 00 \end{array}$
 The Altitude found by observation to day, is — $\begin{array}{r} 61 \text{ — } 58 \end{array}$
 Wh^{ch} Alt. subtr. the remainder is the Zenith distance, $\begin{array}{r} 28 \text{ — } 02 \end{array}$
 Declination of the Sunne to day, is — $\begin{array}{r} 23 \text{ — } 30 \end{array}$
 Wh^{ch} being joyned to $\frac{1}{2}$ Zenith distance, the Lat. is $\begin{array}{r} 51 \text{ — } 32 \end{array}$

This Rule holdeth in all Latitudes of like situation and serveth for ever in this Latitude and all others that are more Northerly then 23. deg. 30. min. provided the Sunne have North declination when you observe his Altitude.

Now you may very easily conceive by this question, that you have to day the greatest Altitude of the Sunne that you can possibly have in this Latitude of 51. deg. 32. min. because the Sunne to day is in the Tropick of Cancer and hath made her greatest North declination which is 23. deg. 40. min. so the Sunne is but 28. deg. 2. min. distant from your Zenith Poynt, which if you subtract from 90. degrees, 00. minutes, the distance of your Zenith from the Horizon, the Sunnes Altitude appeareth to be 61. deg. 58. min. higher then which you shall never find her, here at London.

Second Question.

I Demand, how I shall give the Latitude here at London the 12th. day of December, according to the Altitude observed.

First, I consider the Sunnes declination for the day, and find it 23. deg. 30. min. to the Southward of the Equinoctiall.

Secondly, I consider the situation of my Zenith Poynt, and find the Equinoctiall is betwixt the Sunne and my Zenith because the Sunne hath South declination and my place of being is to the Northward of the Line.

Wherefore now I take the Meridian Altitude with my Geometrical

metricall Instrumēt as afore, which admit I find to be 14. deg. 58. min. which I subtract from 90. deg. 00. min. the whole Quadrāt, and there resteth 75. deg. 2. min. which I say is the distance of the Sunne from my Zenith : And now because the Sunne hath 23. deg. 30. min. South declination, I subtract it from my Zenith distance, 75. deg. 2. min. and there resteth 51. deg. 32. min. which I conclude is the Latitude desired.

Manner of Worke.

	deg. min.
T he whole quantity of your Quadrāt, is alwaies	90 — 00
The Altitude found by observation is	— 14 — 58
The Zenith distance is,	— 75 — 02
The declination of the Sunne, is	— 23 — 30
Which being subtr. from the Zenith distance, the Lat. is	51. 32

By this question, it appeareth plaine that the Meridionall Altitude of the Sunne to day being 14. deg. 58. min. is the least that is possible for you to have in this Latitude, because the Sunne to day is in the Tropick of *Capricorne*, and hath made her greatest South declination. which is 23. degrees, 30. minutes.

Take this briefe Rule for all places having your Zenith situated as afore, that if the Sunne have South declination, you subtract the declination from your Zenith distance, and the remainder is the Latitude : But if the Sunne have North declination, joyne the declination from your Zenith distance and the product is the Latitude desired.

Thus have you the way to find the Latitude according to the situation, of two of the three Zeniths, by observation of the Sunnes Meridionall Altitude. Now for the third, you may conceive it can never happen, but when your being is betwixt one of the Tropicks and the Equinoctiall, for except you are within 23. deg. 30. min. of the Line, it is impossible to have your Zenith betwixt the Sun and the Equinoctiall, but
finding

finding your Zenith so situated, you must proceed to finde the Latitude of the place by the Altitude observed, in this manner; subtract your Zenith distance from the declination of the Sunne that day, and the remainder is the Latitude or breadth from the Equinoctiall desired.

Third Question.

I Demand, how I shall give the Latitude of *St. Christophers* Island the 12th. day of *June*, according to the Altitude of the Sunne observed.

First, seeke the declination of the Sunne for that day, and you will find it 23. deg. 30. min. to the Northwards of the Line.

Then consider the situation of your Zenith Poynt, which will appeare to be betwixt the Sunne and the Equinoctiall. Now take your Geometrical Instrument, and observe the Sunnes Altitude, which admit you find her upon the Meridian of 84. deg. 00. min. above the Horizon, which I subtract out of 90. deg. 00. min. and find the Sunne distant from my Zenith 6. deg. 00. min. Therefore now according to the Rule, subtract 6. deg. 00. min. from 23. deg. 30. min. the declination of the Sunne that day, and the Latitude or breadth that *St. Christophers* is from the Equinoctiall remaineth, which is 17. deg. 30. min.

Manner of worke.

	deg.	min.
The whole quantity of your Quadrant, is	90	00
The Altitude found by observation, is	84	00
The Zenith distance, is	6	00
The declination of the Sunne, is	23	30
The Zenith distance subtr. from the declination Lat.	17	30

Having the Sunne or Perpendicular in any place found by observation, the declination of the Sunne is the Latitude of the

the place : But if when you have the Sunne in your Zenith Poynt, your Ephemerides or calculated Tables giveth no declination, then conclude, that the Equinoctiall Circle runneth through your Zenith Poynt, And that you are in no Latitude or breadth from the Equinoctiall, because you are just under it.

The reason of taking Altitudes.

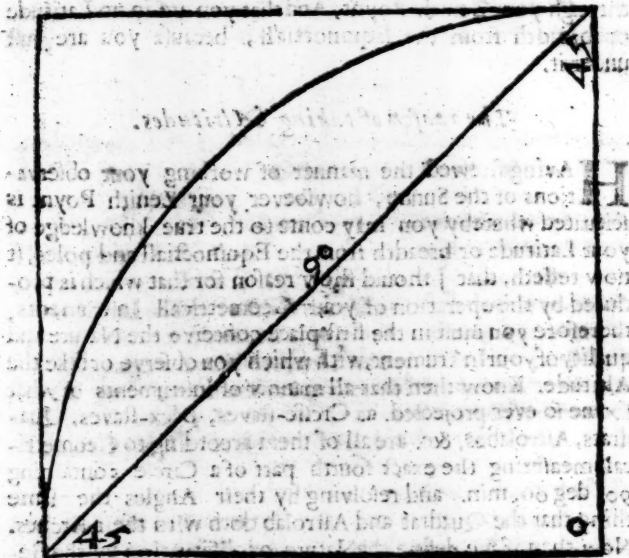
HAVING shewed the manner of working your observations of the Sunne, howsoever your Zenith Poynt is situated whereby you may come to the true knowledge of your Latitude or breadth from the Equinoctiall and poles, it now resteth, that I should shew reason for that which is produced by the operation of your Geometrical Instruments; therefore you must in the first place conceive the Nature and quality of your Instrument, with which you observe, or take the Altitude. Know then that all manner of Instruments of what forme so ever projected, as Crosse-staves, Back-staves, Quadrats, Astrolabes, &c. are all of them according to Geometrical measuring the exact fourth part of a Circle containing 90. deg 00. min. and resolving by their Angles the same thing that the Quadrant and Astrolab doth with their Arches. Now then if we define the Nature of observation by the Geometrical Arch, the reason of all observations of Altitudes taken with any kind of Instrument, will be explained.

First then, *Quadrant* significeth a Square and Arcusse, a portion or part of a Circle, which if it be swept in a Square or equal Parallelogram, one foot of your Compasses standing in any of his intersections, and the other extended the length of either his sides, making that distance his Semidiameter, the Arch is as great as possible may be contained in such a Square; And a subtending side or base being drawne from the extreme intersections of the Arch with the Sides, will make the Square equal to two Right angled *Isoceleses*, as this Figure representeth.

H

The

the place: But if you have the same in your Zenith
 Boy, your Ephemerid Tables given no de-
 The Figure
 The Figure
 The Figure



Now then it is plaine, that the Right-angle of *Isosceles* is
 alwaies equall to his subtending Side or base, which here you
 see intersecteth the Arch, and the two containing sides at two
 places, and maketh his two Accute or sharpe Angles equall
 45. a peece, so you see the Arch is equall to the Right-angle,
 and the two Accute Angles will make another Arch of like
 quantity, which being adjoyned, is an exact Semicircle, so
 then it resteth, that the Quadrat used in observation, is the
 greatest Arch of a Circle that is possible to be described
 within an equall Paralelograme, which will alwayes bee the
 exact fourth part, if your Paralelograme be without fault, and
 therefore

therefore is very properly called a Quadrant. Therefore now finding that my Geometrical Arch, which I observe withall is equal to the Right-angle of *Isephelen* it may most easily draw these Imaginations into your mind.

First. To find the Zenith of the Heavens.

That in what place soever you are, either on shoare or at Sea, that the point which you rest upon is the Center of a Semicircle, and the opposite point in the Heavens is your Zenith, from whence if a Perpendicular line were let fall, it would be the Semiciameter of the Semicircle.

Secondly. To find the Zenith of the Heavens.

That being thus in the Center with your Zenith Perpendicular, you can find no way, but if you observe your visual Line to the Horizon, and remember your Zenith perpendicular, the Arch of the Heavens contained is equal to your Geometrical Arch projected.

Thirdly. To find the Zenith of the Heavens.

That there is nothing contained within your Horizontall Circle, whether it be in the Heavens, or arise from your Superficies, except onely your Zenith Point, but your visual Line will shew that it is a part or portion of the contained Arch.

Fourthly. To find the Zenith of the Heavens.

That all visual Lines except your Zenith and Horizon, intersecteth an Accute or Sharpe Angle with your place of being or Center.

Fifthly. To find the Zenith of the Heavens.

That this Accute or sharpe Angle being once knowne, which your visual line maketh with any body observed, and that you suppose a Perpendicular line to fall from the intersection of the body (and visual Line) to the Superficies

H 2

where.

This Figure sheweth all plaine if well observed, which before was but imagined: And if you consider it aright, and according to my intent you may proceed and take your observations (not as commonly they are taken) but according to an Artift, knowing what you have done.

Of the plaine-Card,

After all the afore-mentioned matters of Navigation are fully understood by the Industrious Practitioner, the plaine-Card would most willingly produce his operations, but in regard his Lineaments will not answer the reall truth in the prosecution of long Voyages. I would not have your expectations frustrated with relying overmuch upon his conclusions; for there are many facill and farre better wayes of accompting all manner of Courfes and Traverfes, by the ayd of Arithmatick and the application of one of the greatest Circles described upon the Sphearicall body of the Terrestiall Globe, which hereafter in the ensuing worke will be manifested: Yet I would not have any man mistake my meaning, and conceive, that I utterly condemne all Charts in *Plaine*, as Instruments of no consequence, for in all short Voyages I doe allow of them, yea and highly approve of them, as the most excellent Directors. As here in the *Sleeve* or Channell betwixt the West Countrey and *France*, there is no like Instrument as the Channell Chart of the largest graduation, and likewise in the *Irish* Seas, and so upon the Coast of *Flanders*, and in generall, in all Inlets, Straights, and Chaunels (provided) that the Hydrographicall descriptions of the Seas, and the Geographycall of the Lands, have beene laid downe by an experienced Artift, but if they have any larger extensions, I must ingeniously confesse, I shall little or nothing at all regard their directions, because it cannot appeare any thing difficult for the meanest Marriner to conceive, that according

to the Meridians described upon all Terrestrial Globes, the plaine-Chart will be found to be mo^t intollerably false, for according to the Globe, all Meridians will intersect each other at the very Poynts, which we terme the Poles; but the plaine-Charts make them all to be Paralels in all Latitudes, then which nothing is more false; and againe, all the degrees of Longitude are false in all Latitudes, except right under the Equinoctiall, because the Meridians and Paralels hold not their proportions as they ought to doe, and therefore it must needs be, that all Courses or Rombes will faile in their directions. And so all his Lynements will be found lame, increasing to greatest Error as you are farre Northerly or Southerly, and therefore may not be over-much followed, if you will have your conclusions crown'd with credit. As for the manner of using your Channell-Chart is so facill, that at the first demonstration common sense will discover all his lynements and uses. Therefore I will save the Labour of defining him in particular, referring you to any Channell Chart that is well described, whereby you cannot bee long in conceiving all his parts in generall.

Of the distance of Places.

TO Saile the most direct course betwixt any two places Assigned, and to discover the most compendious or shortest distance in Degrees, Leagues, and Myles or any other kind of Measure that shall be desired, will require some better knowledge then the use of the plaine Chart, with his Paralell Meridians) and in all Paralels equall degrees of Longitude and Latitude: For surely the intelligent Artift, cannot be so stupid as that he should take the distance discovered by such an Instrument, and conclude that it produceth the reall truth, for the afore-mentioned reasons will sufficiently satisfy, that no such matter may be expected in any great distances: Yet I know there is many will labour much to prove the plaine Chart most infallible and certaine in his operations; but

but their many lame conclusions I dare affirme, doth secretly checke most of them in their conscience, especially if the course have not Elevated or deprest the Poles over-fast; but that the Longitude hath had a farre larger proportion then the Latitude, as in many severall long Voyages. I have seen the experience and prooffe of their reckonings, which have wholly kept them according to their plaine Charts directions: Amongst many, I will resite one passage that happened whilst that I sayled with the *Hollandors*, which many English and Dutch yet living will affirme to be most true, we had two Yaughts or small Ships of the West-India Companies, aboard of whom we had both Dutch and English Officers, that professed the Art of Navigation. Wee had our Commission to discover the Ilands of the *Lucayos*, where having beene some foure Moneths in very much danger, and great store of foule weather, we found that wee were something to the Northward off an Iland called the *Vcanes*, which lyeth in the Latitude of 27. deg. 30. min. and finding that the Golph of *Balhama* set us off to the N. E. and so haust us out from amongst the Ilands, it was agreed, that we should beate up the helme to goe Home: you must understand, that from this Iland we shapt our course for *Flowers*, one of the Wester Ilands, lying in the Latitude of 39. deg. 30. minutes, and to the Eastward of the *Vcanes*, according to most exactt accompt, (as I did calculate) 800. English Leagues, but by the plaine Charts much more; when wee first stood away our course from amongst the Ilands, I then told all those that kept their accompts according to the Charts in *Plano*, that by this runne of so many hundred Leagues, and raising the Pole not above 12. degrees 00. min. they should plainly perceive the Errors of the Instrument; but because most of them had no other meanes to helpe themselves, they stood in his justification, and onely J in his Condemnation; wee proceeded in the course, and kept all our accounts most secret from each other, untill the matter came to be discovered, for when J had runne out the Leagues of Longitude, contained

betwixt the aforesaid places, according to my calculation, I did not use the old Sea-course of keeping my account secret untill we saw the Land: for then I well knew there would be no bad reckonings produced, but according to my observation finding that my Latitude and Longitude had transported me very neere the place of expectation: About setting of our watch I plainly and openly spoke, that if the Gale held, but so as it did untill morning, we should be close aboard the *Jlands of Flowers and Cornes*; these speeches thus spoken, made a mighty confusion amongst all our Artists in generall so that some of them hoping to have had the credit of the cause openly affirmed against me that it was impossible to be so neere the Land, and that wee must runne yet 150. Dutch Myles, which is 200. English Leagues before we should see the Land and so they all in generall concluded wee were so farre distant, some of them being 150. Dutch myles, some 140. some 120. but none of them nearer, in the Night time we spoke with our consort, and it was quickly advertised what I had said; but he held it impossible, and concluded neere upon the same matter as they did aboard us, and so I was condemned of them all in generall. Yet there were some English and Dutch, that having little knowledge themselves, did rely more confident in my conclusion, because in former affaires they had bin eye-witnesses that they had truly answered their expectations, whereupon the matter grew to wagers, with much advantage against me; it was strange to see how resolute they were against their reputations, and how obstinate in their opinions, Yet were not able to render a reason, the Morning came and it was very heafie untill betwixt 9. and 10. of the clock when it cleared up, and now you may be sure the tops would not want some to looke abroad: the first that adventured saved the rest a labour, and shewed us Land right a head about some three Leagues off, to confirme the truth of the matter, we did but step forward and under the Litch of the Fore-saile were eye witnesses, as any man that knoweth those lands will easily conjecture, that
it

it must be very thicke weather, if at that distance we should not discover them upon our decks: this reall truth produced, made them all fall a wrangling at their Charts as most erroneous and false, and now the most intelligent men began to desire means for the amendment of so grosse a fault, upon which occasion, J did then promise, that if occasions would permit, ere it were long they should have the same way of account, which J used for all manner of Voyages, so plainly discovered both to them and all others, that if the Course were never so long and difficult, in regard of shifts of winds and traverſes, yet the true poynt of the Ships beeing should be certainly knowne to the Industrious Practitioner how it was Scituated, in respect of all parts upon the Terrestiall Globe. This hath and is the chiefe cause that the ensuing Worke is now divulged to publicke view, for I could well have kept it as yet in my owne brest to my particular benefit, and saved a great deale of Labour in unlocking and laying open all my Treasure to bee freely shared amongst my Friends. But that J have ever held my promise if possible should be performed. And now J heartly wish, that although I have dispersed the Key in common amongst them, that they may all find an everlasting Treasure to satisfie their expectations.



CHAP. I.

*The way of Sayling by the Arch of the
greatest Circle extended.*



He most excellent way of Sayling, is by the Arch of one of the great Circles applyed or extended, betwixt any two places upon the Terrestiall Globe, by which directions you will not onely saile the most compendious course that is possible, but shall likewise be able to keepe a more exact account of all manuer of courses that you can by any other kind of meanes, and shall be assured of the certaine poynt of your ships being: But it is most necessary before you proceed to the manner of worke, that you should understand the Nature of all Courses betwixt any two places assigned: Therefore the intelligent Artist cannot but conceive at the first sight of any Terrestiall Globe, that all places howsoever situated must in respect of the Spheariaall body, containe a part or portion of a Circle betwixt them. Now then the greater Diamiter that the Circle hath, the less Curue or crooked will his Arches bee. Therefore if wee will find the most direct course, it must be performed by one of the greatest Circles described upon the Globe, and extended betwixt any two places assigned; which extention and none other will give you the exact quantity of Degrees, Leagues, or Myles, that is contained betwixt them, as it appeareth by the graduated Quadrant belonging to all Globes, which is the exact fourth
part

part of the Meridian or Equinoctial, which are Circles of the greatest capacities; that Quadrant being extended betwixt any two places, sheweth the true distance; But to find this portion or part contained without the Terrestrial Globe, will require the consideration of divers matters. And because, it is most proper to explaine their reasons before the operation, that the judicious practitioner may be assisted in the certainty of his Conclusions; therefore we will begin, and first take into our consideration the nature of all Diameters and Semidiameters.

Diameters and Semidiameters.

ALL Diameters and Semidiameters of the Globe, beare proportion each to other, and the same proportion that one Diameter or Semidiameter beareth in respect of another, the same proportion will theyr Circumferences have to each other.

The Signes of Latitude.

THE Signes of any Latitude, are the perpendiculers that are supposed to bee set off from any Degree of the graduated Meridian in the terrestrial Globe, and doth Intersect the Diameter of the Equinoctiall at right Angles; and the signe of the Complement of any Latitude, is a perpendicular, that is supposed to Intersect the Diameter of the Meridian at right Angles; and is ever the Semidiameter of that Paralell.

Paralells.

THE Signes of all manner of Latitudes being Perpendiculars, intersecting the Diameter of the Equinoctiall at right Angles, must of necessity be Paralels to each other, and so are likewise the Signes of theyr Complements.

Proportion of Circles.

All Paralell Circles upon the terrestiall Globe hold a certaine proportion with the Meridian; and the same proportion that the Paralell hath to the Meridian, the same proportion will they Diameters and Semidiameters beare each to other.

As for example, in the Paralell or Latitude of 66. degrees 00. min. the whole Circle is but halfe so bigge as the Meridian; and therefore, a Degree of that Paralell is but halfe the Magnitude of a Degree in the Meridian, and so in like manner, the sine of the complement of that Latitude, or the Semidiameter of the Paralell, is but halfe the quantity of the Semidiameter of the Meridian.

Circular Courses.

There is no Rombe or Course which you can keere, by the direction of any of the poynts of the Compass, which will transport you the neereft way betwixt any two places assigned, but onely East and West right under the Equinoctiall, and North and South which is under a Meridian, for all other Courses produce not one of the greatest Circles; and therefore the Arch contained is more curue or crooked then it would be, if an arch of the Meridian or Equinoctiall were extended betwixt them; and therefore cannot possible be the most direct Course that may be found.

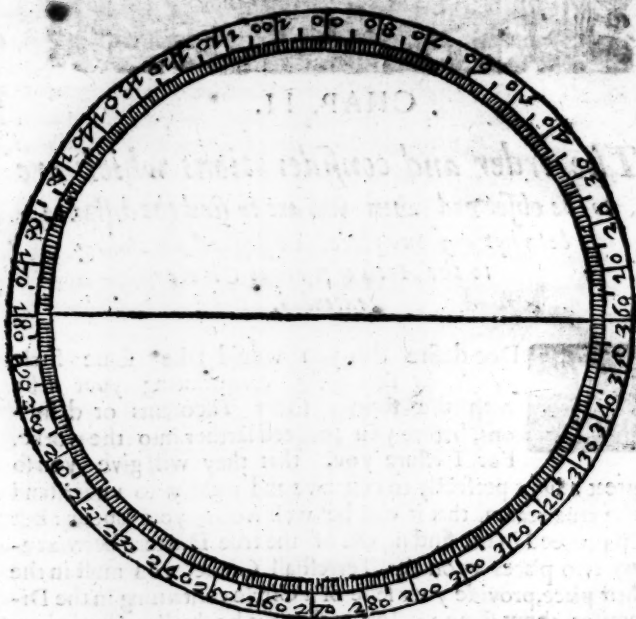


CHAP. II.

*The order and considerations which are
to be observed when you are to find the distance
betwixt any two places Assigned, according
to the Arch of a great Circle
extended.*



Doe desire that you would take some little paines in thoroughly acquainting your selfe with the former short Theorems or definitions, before you proceed farther into the worke. For I assure you, that they will give you so great a sight perfectly to conceive and rightly to understand the true reason, that it will be well worth your labour: But to proceed in the finding out of the true Distance betwixt any two places upon the Terrestiall Globe, you must in the first place, provide your selfe of a Circle containing in the Diameter, about some 12. Inches, for if it be smaller, the degrees will be so little that halfe a degree will be of no consequence, which is tenne Leagues in distance; therefore the larger the better, this Circle must bee divided most exactly into 360. degrees equal parts, with figures set to each 5. degrees, for the readier numbring, and so proceed untill it make 360. deg. which concludeth the whole Circle, as this Figure following plainly expresseth.

The Figure.

The materiall that it should consist of, should be of Brasse or well plained board; but for want of those, you may describe it upon good pastboard: after your Circle is compleatly divided, you must understand, that it doth represent the Equinoctiall Circle described upon all Globes; and therefore is a Circle of the greatest Diamiter, when this easie Instrument is projected and framed, you may proceed and find the true distance betwixt any two places, if you will first take notice of these following observations.

First

First Observation.

First consider, that if the two places which are assigned you to give the true distance according to the Arch of one of the greatest Circles, should be both of them Scituated to the Northwards off the Equinoctiall, and that they should have one and the same Longitude, then reason will resolve the Question without any farther worke, but onely subtracting the lesser Latitude out of the greater, and the true distance will remaine, because the Arch contained betwixt them is a portion or part of the Meridian, which is a Circle of the greatest Diamiter, therefore sheweth the true distance : As for Example.

Question.

I Demand, the true distance according to the Arch of one of the greatest Circles that is contained betwixt the Jland called *Iseland*, and the Jland called *Fero*, one of the *Canarie* Jlands.

Here in this Question, first J consider that both places lye in Northerly Latitude, namely *Iseland* in 66. deg. 00. min. and *Fero* in 28. deg. 00 min. then J consider the Longitudes of the aforesaid places, and it appeareth, that they are both Scituated under one Meridian. which is a Circle of the greatest Diamiter; Therefore according to the former directions, J subtract the lesser Latitude out of the greater, and the Arch contained betwixt them remaineth : As for Example.

The Latitude, of <i>Iseland</i> , is	_____	deg. min.
	66	00
The Latitude of <i>Fero</i> , is	_____	
	28	00
Remeth after subtraction	_____	
	38	00

So it plainly appeareth, that the true distance betwixt *Iseland* and *Fero*, according to the Arch of one of the great Circles contained betwixt them is 38. deg. 00. min. which is

is soone turned into Leagues or Myles, onely by multiplication; for if you multiply 38. deg. 00. min. by 20. which are the Leagues in one degree, either of the Equinoctiall or Meridian, the product yeeldeth the leagues contained betwixt the aforesaid places, and if you multiply those leagues by 3. you have the Myles; therefore it is most manifest, that *Iceland* is distant from *Fero*, one of the *Canary* Ilands, 38. deg. 00. minutes of the Meridian, or 760. leagues, or 2280. Myles.

Second Consideration.

Secondly, you must consider, that if two places bee assigned you to give the true distance according to the Arch of one of the great Circles contained betwixt them, and that one place lyeth to the Southward of the Line, and the other place is Scituated to the Northwards of the Equinoctiall, and yet that both of them should have one Meridian; then onely adde the Latitudes of both places into one summe, you have the true distance in degrees and minutes, which you may turne into degrees or Myles as I shewed before, and by the following Question is manifested.

Question.

I Demand the distance, according to an Arch of one of the Igcreatest Circles, that is contained betwixt *Fayall*, one of the *Wester* Ilands, and *Cape Frio* in *Brazzele*.

In this Question, I first consider the Latitude of both places, and I find that *Fayall* is Scituated in the *Paralell* or Latitude of 39. deg. 00. min. to the Northward of the Equinoctiall, and that *Cape Frio* in *Brazzele*, hath 22. deg. 00. min. of South Latitude, now in regard both places have one and the same Longitude, I onely adde or joyne both Latitudes into one summe, and I have the degrees of the Meridian that is contained betwixt them: As for Example.

Fayall

	deg. min.
Fayall hath North Latitude —————	39 — 00
Cape Frio hath South Latitude —————	22 — 00
Both added into one summe maketh —————	61 — 00

Which is the true distance in degrees of the Meridian or Equinoctiall that is contained betwixt the aforesaid places, which turned into Leagues, maketh 1220. and in Myles amounteth to 3660.

Third Consideration.

THirdly, you must consider, that if any two places be assigned to give the Arch of one of the greatest Circles contained betwixt them, and consequently they are true, and that both places are situated right under the Equinoctiall, then you may onely observe the difference of their Longitudes, and that is their true distance; because the Equinoctiall is a Circle of the greatest Diamiter, but you must ever note, that if the degrees of Longitude amount to more then 180. then subtract them from 360. and the true distance of degrees contained betwixt the aforesaid places will remaine: As for Example.

Question.

Demand the distance, betwixt St. Thomas Iland, which lieth right under the Equinoctiall, admitting that it hath 35. deg. 00. min. of East Longitude, accounting from the Meridian that passeth by the Ilands of Cape Devert, and the mouth of the River of Amazonas, which is likewise Scituated under the Equinoctiall, and is allowed to have 325. degrees of Longitude, accounting from the aforesaid Meridian.

Here in this Question, I onely note the difference of Longitude, and it appeareth that St. Thomas Iland hath 35. deg. 00. min. of East Longitude, which because all degrees of

Longitude, which because all degrees of Longitude ever begin their first account Eastward, I onely reserve that summe untill I have subtracted, 325. deg. the Longitude of the River of *Amazon*, from 360. deg. the beginning and ending of all Longitudes, and there remaineth also 35. deg. 00. minutes, which I adjoyne to the 35. deg. 00. min. of East Longitude where *St. Thomas* Island is Scituated, and they both make 60. deg. 00. min. which being turned into leagues, make 1200. and in myles, amount to 3600. which is the true distance of the aforesayd places according to the plaine of the Equinoctiall extended betwixt them, which is a Circle of the greatest Diamiter: All these Questions hitherunto, have no difficulty in finding the Arch of the Circle contained betwixt them, because their proper courses are all of them under Circles of the greatest Diameters, and therefore are soone resolved, onely with the helpe of addition and Subtraction; Yet I could not omit them as matters of no consequence, in regard I am certaine the Indoltrious Practitioner doth ever desire fully to understand every particular as he proceedeth.



CHAP. III.

*How to find the true distance, according
to the Arch of a Circle extended betwixt
any two places, howsoever
Scituated.*

After all the former considerations are fully understood, you may proceed by the ayd of your great Circle formerly described, and take the true distance that is contained betwixt any two places howso-

howsoever situated; the first thing that you must take in hand whereby you may prosecute the premises, is the graduated Circle, containing 360. degrees; from the Center of which Circle you must take betwixt a paire of Compasses the exact Semidiameter, accounting from the Intersection with the outwardmost Circle of the two, that containeth the single degrees betwixt them, and with the same extension upon any plaine and cleane sheete of paper, sweepe another Circle of the same magnitude; then take your ruler and draw a Diameter at pleasure, running directly through the Center; at the Intersection of this Diameter with the circumference, ever towards the right hand, set in figures 360. degrees, representing the beginning and ending of all manner of Longitudes, and so you are now compleatly ready to resolve any kind of distance that you shall desire, if you observe the nature of the situation of both places, which may be in foure severall respects or kinds, which I will here briefly explaine, that the judicious Practitioner may not at any time be deceived in mistaking the manner of work, for he must understand that upon these foure severall Situations, there ariseth foure severall sorts of worke, which if you should mistake one for another, it would breed great Error and shame to your conclusions; but if you will carefully mind the manner of worke, which is hereafter observed upon the generall Situations, you will never faile, for you may assure your selfe that there can no Question happen, but it will either fall out according to one of these foure Situations, or else in respect of the already considerations formerly manifested.

First Situation.

First one place may be right under the Equinoctiall, and so hath no Latitude, and yet may be in many severall degrees of Longitude, accounting from the Meridian that intersecteth the Equinoctiall at 360. deg. which is the beginning and ending of all manner of Longitudes, and the other place may

have both Latitude and Longitude, yet differing from the first places Longitude.

Second Scituation.

SEcondly, two places may differ both in Latitude and Longitude, and yet may be both of them Scituated either to the Northwards or Southwards of the Equinoctiall.

Third Scituation.

THirdly, two places may differ both in Latitude and Longitude, and one place may be Scituated to the Southward of the Equinoctiall, and the other to Northward.

Fourth Scituation.

Fourthly, there may be two places Scituated in divers Parallels or Latitudes betwixt the Arcticke and Antarticke Poles, that may both of them have one Degree and Minute of Latitude, yet may have severall degrees of Longitudes.

These are the Scituations of all places upon the Terrestiall Globe, so that there cannot be any two places but in respect of each other, they will be found in one of these foure kinds, except they fall in the former Considerations, which have beene at large explained unto you; therefore, if you will seriously observe these short directions, and then if you make application at all times according to the manner of worke performed in the following Questions, you shall never have your expectation deceived.

First Question, according to the first Scituation.

Demand, the distance betwixt the Eastermost part of the Mouth of the great River of *Amazones*, which is Scituated
right

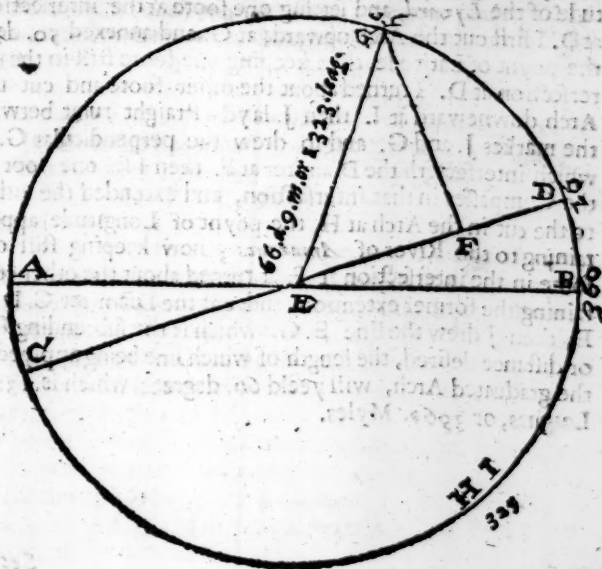
right under the Equinoctiall in the Longitude of 325. deg. and the Head-land in the West of England, called the *Lizard*, Situated in the Latitude of 50. deg. 00. min. and 16. deg. 00. min. of Longitude.

Now it is most apparent, that these two places are according to the first Situation, and therefore the manner of worke in this Question, will serve as an Example for all other of like Nature. First, then having swept a Circle of the same magnitude that your graduated Arch is of, draw a Diameter through the Center (at pleasure,) intersecting the circumference at two certaine places the one towards your left hand, and the other towards your right; and the end of that intersection which is towards your right hand, set in figures 360. deg. representing the beginning and ending of Longitude; then consider the Longitude and Latitude of both places severally, and you will find the Longitude of the River of *Amazones*, is 325. degrees; but because it is Situated right under the Equinoctiall, you need not draw any Diameter from the point of Longitude, onely set one foote of your Compasses right in the intersection of the Diameter with the outwardmost Circle of the two, in your graduated Arch, (that containeth the single degrees betwixt them, and where you see 360. deg. annexed, extending the other foote downewards in the same Circle, untill it cut just the degrees of 325. deg. the Longitude of the place assigned, now keepe the same extension, and transerre it into the same Circle, which formerly you drew of the same magnitude, setting one foote of the Compasses in the intersection of the Diameter, with the Circumference towards the right hand, where you see 360. deg. annexed, and extending the other foote downewards in the Circle untill you have made a marke in the Arch, representing the point of Longitude of the mouth of the River of *Amazones*, and then set out againe that marke the degrees of Longitude in figures, namely 325. deg. then take your Compasses and returne againe to the graduated Circle and set one foote in the former intersection, name-

ly where the Diameter intersecteth the outwardmost Circle on the right hand, where is set in figures 360. deg. then consider the *Lyzards* Longitude, which will appear to be 16. deg. 00. min. therefore extend the other foote of your Compasses upwards in the graduated Circle, untill it poynť or cut just in 16. deg. 00. minutes; now transſerre that extension into your plaine Circle of the ſame magnitude, ſetting one foote in the interſection of that Diameter, with the circumference towards your right hand, where you ſee 360. annexed, and turne about the other foote upwards in the Arch, and there make a marke or poynť, ſetting out againſt it 19. deg. representing the degree of the *Lyzards* Longitude, from which marke or poynť, becauſe the *Lyzard* hath alſo Latitude; you muſt draw a Diameter running directly through the Center of the Circle, then in regard the *Lyzard* hath Latitude, namely 50. deg. 00. min. therefore you muſt retorne againe to your graduated Circle, and ſetting one foote of your Compasses in the former interſection, at 360. degrees extend the other upwards untill it cut or poynť right with 50. deg. in the Arch, then transſerre the ſame extension into your plaine Circle, ſetting one foote of the Compasses in the interſection of the *Lyzards* Diameter with the Circumference; namely, where you ſee 16. deg. annexed, the poynť of the *Lyzards* Longitude; and turning about the other foote, cut your plaine Arch at two certain places; now lay a ſtraight Ruler to thoſe cuts or markes, and from the *Lyzards* Diameter upwards draw a ſtraight line, which will ſtand perpendicular as it ought, and at the interſection which the circumference ſheweth the poynť, of the *Lyzards* Latitude, therefore againſt that interſection, you muſt ſet out 50. deg. representing the ſame matter.

Now from the interſection of this perpendicular with the *Lyzards* Diameter, extend the Compasses untill one foote ſtanding in that interſection, the other foote doth poynť in the Circle with 33. d. the poynť of Longitude of the River of *Amazon*; then keeping one foote ſtill in the former interſection

terfection, turne about the other foote which poynited to 325. deg. in the Circle, and carefully keeping the same extention, cut or make a marke in the *Lyzards* Diamiter, then lay a straight ruler from that marke to the *Lyzards* poynnt of Latitude in the Circle, namely where you see 50. deg. annexed, and draw a streight line betwixt those two places, which is the subtending side or distance desired, therefore taking the length of that line betwixt your Compasses, and applying that extention to the graduated Circle, you will have the degrees and minutes of one of the greatest Circles that is contained betwixt the aforesaid places, which if you turne into Leagues and Myles by Multiplication, you have your full desire; and in this Question, you will find 661. deg. 09. min. which make 1323. Leagues, or 3969 Myles, the manner of this worke is so plainly exprest by the following Figure, that common sence cannot but easily conceive it at first sight.



For first, I swept the whole plaine Circle exactly of the same bignesse of my graduated Arch, as hath bene formerly shewed, then I drew a Diamiter at pleasure running through the Center, as A.B. then at A. I set 360. deg. and brought from my graduated Circle betwixt my Compasses, the distance of the mouth of the River of *Amazons* Longitude, accounting from 360. deg. in my graduated Circle, and set one foote of my Compasses with the same extent in the Diamiter at B. and with the other J cut the Arch downewards at H. and annexed 32 1/2. deg. the degrees of Longitude, then J brought from my graduated Circle betwixt my Compasses, 16. deg. the *Lyzard's* Longitude, and setting one foot in the intersection at B. with the other I cut the Arch upward at D. and annexed 16. deg. the poynr of Longitude, and from that intersection, J drew through the Center the Diamiter D.C. then J brought from my graduated Circle 50. deg. the Latitude of the *Lyzard*, and setting one foote at the intersection at D. I first cut the Arch upwards at G. and annexed 50. deg. the poynr of Latitude, then keeping one foote still in the intersection at D. I turned about the other foote and cut the Arch downeward at I. then J layd a straight ruler betwixt the markes J. and G. and so drew the perpendicular G.F. which intersecteth the Diamiter at F. then I set one foot of the Compasses in that intersection, and extended the other to the cut in the Arch at H. the poynr of Longitude appertaining to the River of *Amazons*; now keeping still one foote in the intersection at F. I turned about the other containing the former extension, and cut the Diamiter C.D. at E. then J drew the line E.G. which is the subtending side or distance desired, the length of which line being applied to the graduated Arch, will yeeld 66. degrees, which is 1320. Leagues, or 3960. Myles.

do y^e Second Question, according to the second
 Situation, being given of the said

I Demand the distance, betwixt the Iland in the West-Indies called the *Barbadoes*, lying in the Latitude of $13.4.00$. min. to the Northward of the Equinoctiall, and hath 313 . deg. of Longitude, and the *Head-land* in *England* called the *Lizard*, is Scituated in the Latitude of 50 . deg. 00 . min. and hath 16 . deg. 00 . min. of Longitude.

Here in this Question, having your plaine Circle swept with the Diamiter drawne through at pleasure, as before numbred with 360 . deg, at the interfection towards your right hand, consider the Longitudes of both places severally, which Longitudes with a paire of Compasses take out of your graduated, and transerre them into your plaine Circle, setting one foote alwayes at the interfection of the Diamiter, towards your right hand where you see 360 . deg. annexed, and with the other foote cutting the poynts of Longitude in the plaine Circle as hath beene shewed before, annexing the figures representing their severall degrees.

Note.

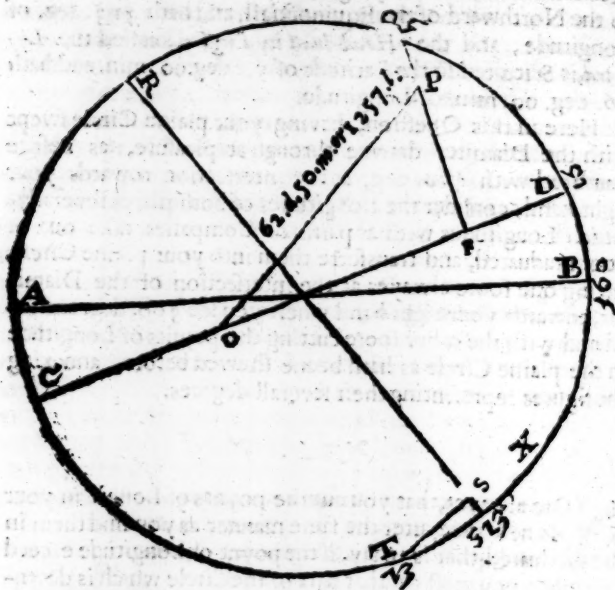
Note alwayes, that you cut the poynts of Longit. in your plaine Circle, after the same manner as you find them in the graduated; that is to say, if the poynt of Longitude exceed 180 . then you must cut that part of the Circle which is downwards from the Diamiter, but if Lesse then upwards: as in this Example, the Longitude of the *Lizard* is 16 . deg. 00 . min. which is lesse then 180 . degrees; therefore when you transerre that poynt of Longitude into your plaine Circle, as before, you must cut it upwards in the Circle, also when you cut the Longitude of the *Barbadoes*, in your plaine Circle which is 313 . deg. and therefore exceedeth 180 . deg. which is a Semicircle, you must cut that poynt of Longitude under

L

the

the arch, or downwards from the Diamiter.

All which will most plainly appeare, if you Induciously observe this following Figure, with the manner of worke continued.



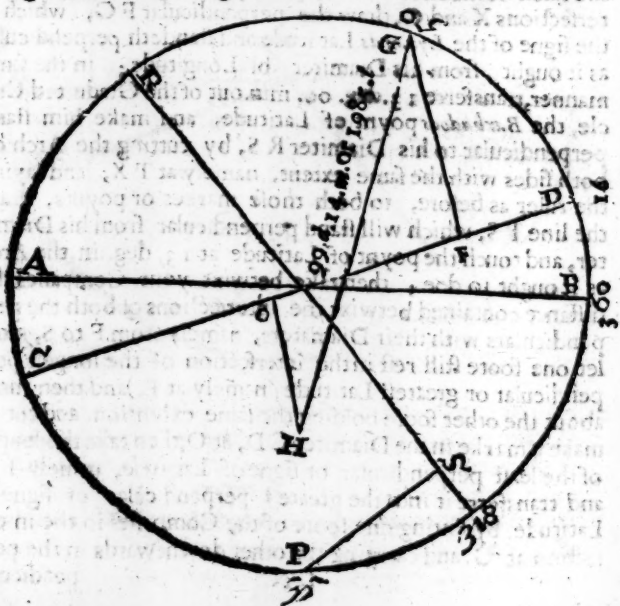
After the points of Longitude are transferred and cut in the plaine Circle (as hath beene shewed before) draw from those points of Longitude, two Diameters intersecting each other in the Center, as CD, and RS, then returne to your graduated Circle, and set one foote of your Compasses in the Intersection of that Diamiter, with the outwardmost Circle of the two, which containeth the single degrees betwixt them,

them, and where 360. deg. is annexed, extending the other foote to the poynts of both places Latitudes (severally) which extensions, transerre into your plaine Circle making them stand perpendicular from their Diamiters, of Longitude, and intersecting the plaine Circle at their poynts, or signes of Latitude; as for Example, take 50. deg. betwixt your Compasses, the Latitude of the *Lyzard*, and with the same extension returne to your plaine Circle, and there observe where the Diamiter of the *Lyzards* Longitude intersecteth the plaine Arch, which you will find is at D: therefore set one foote of your Compasses in that intersection, and extend the other first upwards, and cut the Circle at G, then turne about the Compasses keeping still one foote in the former intersection, and retaining the same extension, cut the Arch downwards at X, then lay a straight ruler to the intersections X and G, draw the perpendicular FG, which is the signe of the *Lyzards* Latitude, and standeth perpendicular as it ought from his Diamiter of Longitude; in the same manner, transerre 13. deg. 00. min. out of the Graduated Circle, the *Barbadoes* poynt of Latitude, and make him stand perpendicular to his Diamiter RS, by cutting the Arch on both sides with the same extent, namely at TX, and laying the ruler as before, to both those markes or poynts, draw the line TS, which will stand perpendicular from his Diamiter, and touch the poynt of Latitude at 13. deg. in the Arch as it ought to doe; then take betwixt your Compasses the distance contained betwixt the intersections of both the perpendiculars with their Diameters, namely from F to S, now let one foote still rest in the intersection of the longest perpendicular or greatest Latitude (namely at F,) and then turne about the other foote holding the same extension, and cut or make a marke in the Diamiter CD, at O, then take the length of the least perpendicular or signe of Latitude, namely TS, and transerre it into the greatest perpendicular or signe of Latitude, by setting one foote of the Compasses in the intersection at G, and carrying the other downwards in the per-

pendicular or signe G F. cut the poynt P. then draw the line O P. which is the subtending side or distance desired. and in this Question if you take the distance O P. betwixt your Compasses and apply it to your graduated Arch, it will there yeeld you 62. degrees, 50. min. which is 1157. leagues, or 3771. myles.

Third Question, according to the third Situation.

Demand the distance betwixt the mouth of the great River in *Bravile*, called the River of *Plata*, which lyeth in 25. deg. 00. min. of South Latitude, and in Longitude 318. deg. and the *Head-land* in *England*, called the *Lizard*, which lyeth in 50. deg. 00. min. of North Latitude, and hath 16. deg. 00. min. of Longitude.

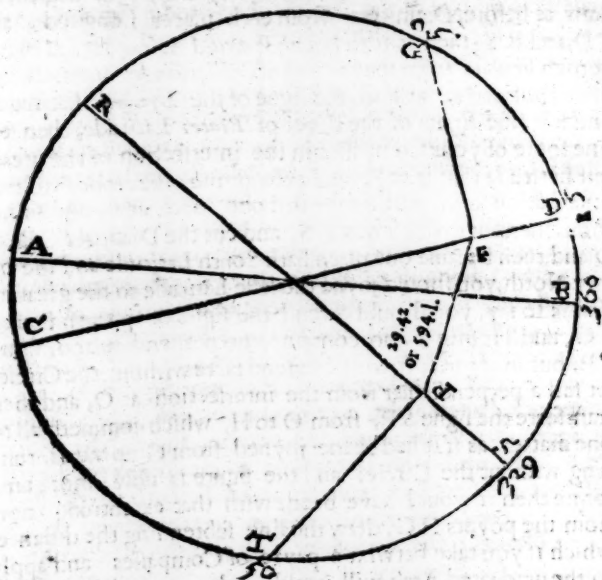


First, sweep the plaine Circle of the same Magnitude, of your graduated as the figure sheweth, then draw the Diameter A B, annexing at the intersection at B, 350. deg. then draw as before, Diameters from each places Longitude, as C D, and R S; then as hath beene shewed before, let fall their perpendiculars from theyr poynts of Latitude intersecting their Diameters, as F G, the signe of the *Lyzards* Latitude, and S P, the signe of the River of *Plates* Latitude, then set one foote of your Compasses in the intersection of the greatest Latitude that is at F, and extend the other foote to the intersection at S, now keepe still one foote at F, and turne about the other which was at S, and cut the Diameter C D, at O, and then because one place hath South Latitude and the other North, you should joyne the lesse Latitude to the greater, that is to say, you should extend the signe or perpendicular F G, untill it might also containe the perpendicular or signe S P, but in regard it would extend farre without the Circle, let fall a perpendicular from the intersection at O, and then transerre the signe S P, from O to H, which commeth all to one matter, as if it had beene joyned from G upwards, running without the Circle; and the figure is now more uniforme then it would have beene with that extention; now from the poynts H G, draw the line subtending the distance, which if you take betwixt a payre of Compasses and apply to the graduated Arch, will yeeld 99. deg. 14. min. or 1985 Leagues.

Fourth Question, according to the fourth Situation.

I Demand the distance, betwixt Cape Bonivist in *Newfoundland* and the *Head-land*, called the *Lyzard*, both places having nearest 50. deg. of North Latitude, Cape Bonivist in the Longitude of 319. degrees, and the *Lyzard* in 16. degrees.

The Figure.



Here in this Question, sweep the plaine Circle of the same magnitude with your graduated, and draw the Diameter through the Center, annexing at the intersection towards your right hand 360. as the Figure sheweth; and now because Cape Bonivist is Situated in the Longitude of 329. degrees, set one foote of your Compasses in the intersection of the Diameter with your graduated Circle, where 360. is annexed, then extend the other foote in the same Circle untill it cut exactly at 329. degrees, which extension transerre into the plaine Circle cutting the Arch downwards from the

the intersection of the Diamiter, and from that cut or poynt, draw the Diamiter R S. and so in like manne-
 transferre the poynt of the *Lyards Longitude*, and draw the
 Diamiter C D, then as hath beene formerly shewed trans-
 ferre the poynts of both places Latitudes, and draw the per-
 pendiculars F G, and P T, which cut their Diamiters at right-
 angles, from which intersections draw the line F P, which is
 the subtending side or distance, and in this Question if you
 take that line betwixt your Compasses, and apply it to your
 graduated Circle, it will there yeeld you 29 deg. 42. min.
 which is 594. Leagues, or 1782. Myles.

These Questions which have beene already fully explai-
 ned, both by Figure and Worke, cannot possible seeme any
 thing difficult to the industrious, but rather with small prac-
 tice will prove most facill and delightfull in operations, all
 things being already so plainly demonstrated, and perfectly
 drawne forth for the obtaining of the true knowledge in all
 manner of distances, what may be the portion or part of one
 of the greatest Circles contained betwixt them; by which
 portion the true distance in any kind of measure is produced,
 as hath beene formerly expresse and sufficiently explained,
 so that it is needlesse and unnecessary to take farther paines
 in demonstrating the way of finding the true Distance be-
 twixt any two places, according to the application of one of
 the greatest Circles, because by the former questions, if at a-
 ny time there should arise any doubt in your worke, you may
 be resolved; if according to the Scituation of your places As-
 signed, if you have relation to these former questions, and
 there make application according to the manner of worke
 produced, you can neither faile nor find fault.

Now after you are able to find the true distance of any two
 places (each from other) that are Scituated upon the Terrestri-
 all Globe, you should in the next place learne to know upon
 what poynts of the Compasse you must prosecute the Course
 according to the plaine of the great Circle extended; but in
 regard that it requires the certaine knowledge of the quan-
 titie

title of each severall Angle, that the portion or parts of the greatest Circle marked with each severall Meridian, other-
wayes you cannot sayle the most direct Course, although you
find the true distance by the former Rules; the positions of
which Angles are so subtill, and will seeme so obdurate to
many Seamen, that they will not endure to take so much
paines as is required in the resolving of them, according to
the doctrine of Triangles. Therefore I have devised a more
facill way for the performance of the premisses, onely by the
rules of Proportion, and the ayde of my Tables here inser-
ted; the use of which Tables with the rules of Reduction,
and divers other reasons and observations; you must be well
acquainted with all, before you can apply the rule of three or
proportion to find out your desire; First then, we will begin
and draw forth our Tables of Longitudes.

The

The Table of Longitudes which I have Calculated, containing the Leagues, Miles, and Staves, that make a Degree in any Parallel, betwixt the Equinoctial and the Poles.

				20. Leagues.							
Latit.	Lea.	M.	Stav.	Latit.	Lea.	M.	Stav.	Latit.	Lea.	M.	Stav.
1	19	2	994	31	17	0	431	61	9	2	89
2	19	2	984	32	16	1	886	62	9	1	169
3	19	2	922	33	16	2	322	63	9	0	240
4	19	2	856	34	16	1	743	64	8	2	303
5	19	2	772	35	16	1	153	65	8	1	357
6	19	2	671	36	16	0	543	66	8	0	401
7	19	2	553	37	15	2	942	67	7	2	443
8	19	2	417	38	15	2	281	68	7	1	476
9	19	2	265	39	15	1	030	69	7	0	500
10	19	2	98	40	15	0	962	70	6	13	524
11	19	1	898	41	15	0	485	71	6	11	534
12	19	1	691	42	14	2	589	72	6	0	540
13	19	1	462	43	14	1	882	73	5	2	542
14	19	1	218	44	14	1	162	74	5	1	538
15	19	0	919	45	14	0	426	75	5	0	519
16	19	0	861	46	13	0	681	76	4	2	511
17	19	0	283	47	13	1	923	77	4	1	497
18	19	0	63	48	13	1	149	78	4	0	474
19	18	2	732	49	13	0	364	79	3	2	449
20	18	2	383	50	12	2	567	80	3	1	419
21	18	2	17	51	12	1	130	81	3	0	386
22	18	1	632	52	12	0	941	82	2	2	350
23	18	1	233	53	12	0	109	83	2	1	312
24	18	0	814	54	11	2	267	84	2	0	271
25	18	0	409	55	11	1	45	85	1	2	229
26	17	2	927	56	11	0	553	86	1	1	185
27	17	2	461	57	10	2	679	87	1	0	140
28	17	1	980	58	10	1	799	88	0	2	93
29	17	1	579	59	10	0	902	89	0	1	47
30	17	0	961	60	10	0	000	90	0	0	000

The Order to be observed in this Table

THE 20. Leagues which you see placed by themselves in the Front of this Table, sheweth, that 20. Leagues will make one degree of Longitude under the Equinoctiall, then the first Colume towards your left hand, manifesteth the degrees of Latitude beginning at one degree from the Equinoctiall, and ending at 30.d. marked in the Head with (*Latir.*) importing the same thing, the three next Columes towards your right hand, sheweth the Leagues, Myles, and Staves, that answer to one degree of Longitude in any of those Latitudes, marked in the head with (*Lea. Msl. Staves.*) the fifth Colume beginneth the Latitude at 31. degrees, extended until it make 60. degrees, and the three next towards your right hand shew the Leagues, Myles, and Staves, that answer to each of those degrees; the 9. Colume taketh the Latitude againe at 61. degrees, and concludeth with 90. degrees; the three next and last Columes, shew the Leagues, Myles, and Staves that answer to those degrees; as for Example, how many Leagues will make one degree of Longitude in the Latitude of 20. degrees, search for 20. degrees in the first Colume towards your left hand, then right against that Latitude in the three next Columes towards your right hand, you shall find 12. leagues, 2. Myles, 385. Staves.

*The Table of Difference of Longitude in all
Latitudes.*

20. Leagues.											
Latit.	lea.	M.	Stav.	Latit.	lea.	M.	Stav.	Latit.	lea.	M.	Sta.
1	0	0	6	31	2	2	569	61	10	0	911
2	0	0	36	32	3	0	114	62	10	1	831
3	0	0	78	33	3	0	678	63	10	2	760
4	0	0	144	34	3	1	258	64	11	0	769
5	0	0	228	35	3	1	848	65	11	1	643
6	0	0	329	36	3	2	457	66	11	2	597
7	0	0	447	37	4	0	81	67	12	0	557
8	0	0	583	38	4	0	719	68	12	1	524
9	0	0	735	39	4	1	370	69	12	2	498
10	0	0	910	40	4	2	38	70	13	0	479
11	0	1	102	41	4	2	717	71	13	1	466
12	0	1	309	42	5	0	411	72	13	2	459
13	0	1	538	43	5	1	118	73	14	0	458
14	0	1	782	44	5	1	828	74	14	1	462
15	0	2	41	45	5	2	574	75	14	2	471
16	0	2	319	46	6	0	319	76	15	0	485
17	0	2	617	47	6	1	78	77	15	1	503
18	0	2	937	48	6	1	851	78	15	2	526
19	1	0	268	49	6	2	636	79	16	0	552
20	1	0	615	50	7	0	433	80	16	1	581
21	1	0	983	51	7	1	870	81	16	2	614
22	1	1	368	52	7	2	59	82	17	0	650
23	1	1	769	53	7	2	881	83	17	1	688
24	1	1	186	54	8	0	783	84	17	2	729
25	1	2	591	55	8	1	585	85	18	0	771
26	2	0	73	56	8	2	447	86	18	1	815
27	2	0	539	57	9	0	321	87	18	2	860
28	2	1	20	58	9	1	201	88	19	0	907
29	2	1	521	59	9	2	98	89	19	1	954
30	2	2	39	60	10	0	000	90	20	2	000

THis Table hath the same order as the former, the 20. Leagues placed in the Front, shewing that so many make one degree in the Equinoctiall, which is a Circle of the greatest Diamiter; the first Columnne towards the left hand, shewing the Latitude from one degree from the Line; to 30. deg. The fifth Columnne, sheweth the Latitude again from 31. deg. to 60. deg. and the 9th. Columnne from 61. untill it conclude with 90. degrees, the rest of the Columnnes shew the difference that is betwixt one degree of Longitude in any paralell or Latitude, if it be compared with 20. Leagues, which is a degree in the Equinoctiall, As Example in the Latitude of 4. degrees from the Line, your Table sheweth 144. Staves, which signifie, that a degree of Longitude in that Paralell is lesse then 20. leagues, which is a degree in the Equinoctiall by 144. Staves lengths; in like manner, if you demand the difference of one degree of Longitude, in the Latitude of 45. degrees; my Table will shew you 5. leagues, 2. myles, 574. Staves, which explaineth, that one degree in that Paralell, is so much lesse then 20. leagues, or one degree in the Equinoctiall.

The

*The Table of Longitudes which I have Calculated in
single Staves, shewing how many make one Degree in any
Paralell betwixt the Equinoctiall
and Poles.*

60000.					
Latit.	Staves.	Latit.	Staves.	Latit.	Staves.
1	59994	31	51431	61	29089
2	59984	32	50886	62	28169
3	59972	33	50322	63	27240
4	59856	34	49742	64	26303
5	59772	35	49152	65	25357
6	59671	36	48543	66	24405
7	59553	37	47919	67	23443
8	59417	38	47281	68	22476
9	59265	39	46630	69	21502
10	59090	40	45962	70	20521
11	58898	41	45283	71	19534
12	58691	42	44589	72	18541
13	58462	43	43882	73	17542
14	58218	44	43162	74	16538
15	57959	45	42426	75	15529
16	57681	46	41681	76	14515
17	57383	47	40922	77	13497
18	57063	48	40149	78	12474
19	56732	49	39364	79	11448
20	56385	50	38576	80	10419
21	56017	51	37730	81	9386
22	55632	52	36941	82	8350
23	55233	53	36109	83	7312
24	54814	54	35267	84	6271
25	54409	55	34415	85	5229
26	53927	56	33553	86	4185
27	53461	57	32679	87	3140
28	52980	58	31799	88	2093
29	52479	59	30902	89	1047
30	51961	60	30000	90	0000

The Order observed in this Table.

THe 60000. which you see are placed in the Front, shew you that so many Staves length, in the Equinoctiall, will make one degree; then the first Columne towards your left hand, sheweth the Degrees of Latitude beginning at one degree distant from the Line, and extending untill it yeeld 30. deg. The second Columne towards your right hand, produceth the single Staves lengths, that are contained in one degree of Longitude, in any of those Paralels or Latitudes: The third Columne beginneth the degrees of Latitude againe, at 31. deg. and extendeth untill it make 60. deg. The fourth sheweth the single Staves contained in each of those degrees; the fifth, taketh the Latitude, at 61. deg. and concludeth with 90. deg. and the sixt and last, sheweth the single staves that are contained in one degree of Longitude, in any of those Latitudes of paralels. *As for Example;* If you desire to know how many single Staves in length will make one degree of Longitude in the Latitude of 18. deg. search in the first Columne, for the Latitude of 18. deg. and in the next towards your right hand you shall find, 57063. which are the single staves contained in one Degree of Longitude in that Latitude: if you require how many will make one degree in the Latitude of 49 search in the third Columne for that Latitude, and in the next towards your right hand, you shall find 39364. which answereth the question. &c.

The use of these Tables.

THe many uses that may be made of these Tables in the famous Art of Navigation, are not more easie then excellent, for all manner of Sea-men, which desire to have their Conclusions crown'd with everlasting credit: For by their ayde and assistance you shall certainly know all times, to what paralell or Latitude soever that you sayle, the true propor-

proportion of that parallell, in respect eyther of the Meridian, or Equinoctiall. By which you are made able to correct the falsenesse of the Charts in *plano*, which have equall degrees of Latitude and Longitude in all parallels: Also in any course you may find your distance Meridionall, yeelding such exquisite truth that it shall concurre most exactly with the minute of Latitude, found by your dayly observation: The Accompt of your ships way is certainly knowne by their ayde and application, let your course be upon any poynt or points of the Compasse (yea although you were to sayle East or West in a parallell according to your plaine Chart :) The points of your Compasse are found out by their helpe, which you must steere upon in sayling betwixt any two places: The distance betwixt any two places upon the terrestiall Globe in respect of their severall paralels, is straight found out in any kind of measure; As likewise, if they be situated in one and the same Paralell or Latitude: also any number of degrees in any parallell, by the helpe of the aforesayd Tables, are instantly reduced into Leagues, Miles, or single Staves: You may likewise as soone know how many single staves in length, will make one or many degrees in all paralels: Also, any number of single staves, are immediatly reduced into leagues, Miles, or Degr. of Longitude according to any Latitude desired. The whole Circumference of the Globe in all manner of Latitudes by their helpe is forthwith most truly measured according to the Circular paralels, with infinite other excellent conclusions, which I am certaine the intelligent Seaman will dayly discover, may most facilly be performed by there ayde and application rightly applyed and vsed, only in the plaine rules of Proportion, commonly called the Golden Rule, or rule consisting of three Numbers, which no Seaman that taketh charge of conducting a Ship through the Sea, should be ignorant of such easie Arithmeticke. Yet I am certain, there are divers which are not over perfitt in those plaine proportions; therefore those which finde theyr Arithmeticke will not well reach to that pitch, may performe
most

most of the former Conclusions, onely with the helpe of my former Tables, Addition, Subtraction, and a little Division rightly applyed, as the cause shall require, which hereafter shall be manifested, by divers Questions and Examples. But for those men which are altogether ignorant in the use of all manner of Numbers wrought by the Pen, it is impossible for me to give them any instructions; whereby they may gaine any good: Neyther doe J desire to spend my labour in fruitlesse hope, imagining J might beate braines into a Blocke, or turne a Copper Beaker into a gold Cup, I was never so great a Philosopher, neither doe J intend to trouble my selfe with such Conclusions; therefore such feathered Fowle cannot guild their Plumes through my directions: But to the former purpose, you may understand, that these Tables which J have calculated, were drawne forth according to the *Spanish* Account, which alloweth 17 $\frac{1}{2}$ Leagues, to one Degree of the Equinoctiall or Meridian, which is the best allowance according to their proportion, used in drawing forth their Leagues; as shall be proved at large in the next Chapter: which sheweth the Leagues, Myles, and Staves lengths, which you must raise upon all Courses or Poynts of the Compasse, before you can layle or deprese the Pole one Degree; to which place J referre you for your farther satisfaction, yet in the meane time you may understand, that each Stave is allowed to containe in English measure, ten Foot, foure Inches, one Barley corne, and one third part of one Barley corne; one thousand of those staves make one English Myle, three thousand one League, and twenty of those Leagues, one Degree, eyther in the Meridian or Equinoctiall (Circles of the greatest Diamiter) which punctually answereth the *Spanish* proportion; that alloweth 17 $\frac{1}{2}$ Leagues in eyther of those Circles; to be one of their Degrees,

The



The Leagues which you must Sails upon any Course, whole, halfe, or quarter Points of the Compass, before you shall raise or depress the Pole one Degree, and how farre you will be distant from your first Meridian.

There hath beene very much mistaking the matter, by divers men, that have undertaken to discover the Leagues in proportion, that answer to each severall Rombe or Course, in raising or depressing the Pole one Degree; the chiefe reason arising, from the diversity of measures which they have made use of in their Calculations; some allowing 5. of our Feet to make one Geometrical pace, one thousand of those paces one Mile, three of those Miles one League, and 20. of those Leagues to make one Degree, in the Equinoctiall or Meridian; then which there is nothing more false, for it will not yeeld the measure, according to the real truth that is contained in 20. Leagues, when it must answer the proportion of one Degree in the Meridian; others againe, doth allow 1700. English yards to make one mile, 3. of those Miles to yeeld one League, and 20. of those Leagues to one Degree of the Meridian; which is likewise contrary to the true proportion: And divers others have committed the like Errors; but I trust you will find my following Table, which I have calculated to that purpose, most precise in the true proportion, which I drew with some paines from the *Spanish* accompt, that alloweth $17\frac{1}{2}$ Leagues to one Deg. of the Meridian; which proportion the *Spaniards* with much trouble and cost, obtained by measuring most exactly upon the Land, keeping ever under their first Meridian, untill by observation they found the Pole rayed or depressed one Degree, which according to their experimentall Conclu-

hence did most precisely fall out at the expiration of 17. of
 their Leagues, which doctely agrees with Mr. Normoods Ex-
 periment lately made in England, as appeares in his Sea-mans
 Practise. Now the proportion of those Leagues, they did
 thus project, or draw forth, 4. Barley Cornes, to make one
 Finger breadth, 16. Fingers one Foote, 5. of those Feet to make
 one pace, and 100. of those paces to yeeld one League, and
 17. of those Leagues to make 1. deg. in the Meridian: Which
 measure I have reduced for the generall good into our *English*
 measure, drawing it forth in this manner; 3. Barley Cornes to
 make one Inch, 12. of those Inches to yeeld one foote, and
 6. of those feet, 1. Inch, one Barley corne, and one third part
 of one Barley corne, to make one Staves length; one thousand
 of those Staves to make one Myle, three thousand to yeeld
 one League, and 10. of those Leagues to make one Degree
 either in the Meridian or Equinoctiall; Here you have my
 way of projecting, which if you please to make tryall by way
 of Reduction; I am certaine you shall find it most exact-
 ly correspondent in all poynts to the *Spanish* Account,
 which hath not beene hither unto so truly reduced by
 any Man.

that is contained in 100. Leagues, when it is reduced into
 degrees, minutes, and seconds, in the Meridian, or Equinoctiall,
 shall show you that it will make one mile, 10. of those
 Miles to yeeld one Degree, and 10. of those Degrees to
 make one Meridian; which is likewise contrary to
 the proportion: And divers others have beene
 devised, but I will find my following The-
 ore which I have devised to be the truest, most precise, and
 easiest proportion, which I draw with some small
 the Spanish account, that sheweth 17. Leagues to one
 Degree of the Meridian, which proportion the Spanish
 hath used, and called it the true proportion, but I have
 found it to be false, and have devised this, which I have
 called the true proportion, which I have found to be the true
 proportion, which I have found to be the true proportion.

The Table of English measure, according to the Spanish proportion

Leagues, Miles, and Staves, of the Course or Rhombe, which answereth in raising or depressing the Pole one Degree.

Course	Leag.	Mil.	Stav.	Course	Leag.	Mil.	Stav.
North.	10	0	000	North.	0	0	000
$\frac{1}{2}$	20	0	071	$\frac{1}{2}$	0	2	949
$\frac{1}{4}$	30	0	201	$\frac{1}{4}$	1	2	916
$\frac{3}{4}$	40	0	354	$\frac{3}{4}$	2	2	853
N. by West.	50	1	173	N. by West.	3	2	034
$\frac{1}{2}$	60	1	854	$\frac{1}{2}$	4	0	031
$\frac{3}{4}$	70	2	697	$\frac{3}{4}$	5	0	102
N. N West.	80	2	723	N. N West.	6	0	482
$\frac{1}{2}$	90	1	241	$\frac{1}{2}$	7	0	512
$\frac{3}{4}$	100	0	375	$\frac{3}{4}$	8	0	382
$\frac{1}{4}$	110	2	037	$\frac{1}{4}$	9	2	079
$\frac{3}{4}$	120	0	948	$\frac{3}{4}$	10	2	955
N W. by W.	130	1	159	N W. by W.	11	2	089
$\frac{1}{2}$	140	2	703	$\frac{1}{2}$	12	1	561
$\frac{3}{4}$	150	2	625	$\frac{3}{4}$	13	1	254
$\frac{1}{4}$	160	2	970	$\frac{1}{4}$	14	2	372
North-west	170	0	852	North-west	15	0	006
$\frac{1}{2}$	180	2	340	$\frac{1}{2}$	16	0	207
$\frac{3}{4}$	190	1	560	$\frac{3}{4}$	17	1	086
$\frac{1}{4}$	200	1	710	$\frac{1}{4}$	18	2	886
N W. by W.	210	2	997	N W. by W.	19	2	726
$\frac{1}{2}$	220	2	721	$\frac{1}{2}$	20	2	119
$\frac{3}{4}$	230	1	245	$\frac{3}{4}$	21	1	212
$\frac{1}{4}$	240	2	310	$\frac{1}{4}$	22	0	834
W. N West.	250	0	786	W. N West.	23	0	852
$\frac{1}{2}$	260	1	134	$\frac{1}{2}$	24	2	727
$\frac{3}{4}$	270	2	595	$\frac{3}{4}$	25	2	681
$\frac{1}{4}$	280	0	861	$\frac{1}{4}$	26	2	451
W. by North	290	1	548	W. by North	27	2	831
$\frac{1}{2}$	300	1	113	$\frac{1}{2}$	28	2	681
$\frac{3}{4}$	310	1	335	$\frac{3}{4}$	29	2	130
$\frac{1}{4}$	320	2	091	$\frac{1}{4}$	30	2	118
West.	000	0	000	West.	000	0	000

The Navigator.

*Certaine Rules of Reduction, performed by the ayde
of my former Tables, and a little Arithmetick,
rightly applied.*

After you have taken heedfull observation of my former Tables, which I have carefully calculated according to the Spanish account, which alloweth 17 $\frac{1}{2}$ Leagues to be one Degree in the Meridian; it followeth most fully, that you should endeavour to acquaint your selfe with all manner of Rules of Reduction, whereby you will be able upon all occasions (with the helpe of former Tables) most readily to reduce any kind of measure into what other Denomination you desire, as by these following questions is plainly expressed.

*A Rule how to reduce any number of single
Staves into Leagues.*

Vhen you have any certaine number of single Staves that you would reduce or turne into Leagues: First set downe the given number, then cut off three of the last figures towards your right hand, which figures so cut or separated from the rest, doth at all times shew you the odde Stave that will happen, because they can never at no time yeeld either Myle, or League, then take the residue of the figures which remaine towards your left hand, and divide them by 3. and the quotient will yeeld you the Leagues desired; if any thing remains upon the Division, they are ever Myles, and your remainder will never exceed 2. As for Example.

First Question of Reduction.

Demand, what number of Leagues will be contained in the Summe of 6974895, Staves in length.

Answer.

Manner of worke, — 6974 895 2324 — 2 — 895
3373.

Here in this Question according to the manner of worke which you see performed, you may observe that 895. were first cut off with a downe-right dash of the Penne, from the given Number, which sheweth the odde Staves as before, then the residue of the Figures towards the left hand, namely 6974. being divided by 3. the quotient doth yeeld 2324. leagues and 2. remaining upon the Division, which sheweth that two odde myles happen upon this Question, and so you cannot but plainly perceive, that 2324. leagues, two myles, 895. Staves, answereth the former demand.

A Rule how to reduce any Number of single Staves, into Degrees of Longitude, according to any Paralell.

When you have any Number of Staves given; that you would turne into degrees of Longitude, according to any Paralell or Latitude that you desire. First, set downe the number of Staves, then search in my Table of Longitudes calculated in single Staves, how many will make a degree in that Paralell, which must bee your Divisor to divide the summe given, and the quotient will shew you the degrees desired; if any thing remaine upon the division, they are ever the odde Staves, which will not amount to make a Degree; therefore you may reduce them most readily into Leagues and Myles, as I shewed you before.

Second Question of Reduction.

Demand, how many degrees of Longitude, 745948. single Staves, will yeeld in the Paralell or Latitude of 35. deg. 00. min.

N 3

Here.

Here in this question, you must first set downe 745948. the number of the Staves given, then search in my Table of Longitudes calculated in single Staves, how many will make one Degree in the Latitude of 25. deg. co. min. and you shall finde 34409. with which summe, if you divide 745948. there commeth into the quotient 13. which are the Degrees of Longitude desired, and there remaineth upon the Division, 38631. which are single Staves, that will not make one Degree of Longitude in the aforesaid Latitude: therefore you may reduce them into Leagues, Myles, and Staves, as I have shewed before, and they will yeeld you 13. leagues, 2. myles, 631. Staves. As for Example.

Manner of Worke. —

38		
59	63	
745948	1	le. m. stav.
344099		12. 2. 631.
3440	2	
	38.631	12
	33	

*A Rule to reduce the Degrees of Longitude, in any
Paralell or Latitude, into single
Staves.*

First, set downe the Degrees which you would reduce into Staves, then search in my Table of Longitudes, in single Staves, how many answer to one Degree of Longitude in that Latitude which you define: multiply that summe by the Degrees, and you have the Staves. As for Example.

Third Question of Reduction.

I Demand, how many single Staves are contained in 19 Degrees of Longitude, in the Paralell or Latitude of 50. De.

Manner

	58567
	19
Manner of Works. —	347103
	38567
	732773

Here in this Question. you may perceive by the manner of worke. that 38567. are the single Staves which make one Degree of Longitude in the Paralell or Latitude of 50. deg. which Staves being multipliyed by 19. Degrees, will yeeld 732773 which are the single Staves contained in 19. Degrees of Longitude in the Latitude of 50. Degrees, which antiwereth the Question.

A Rule to reduce any number of Leagues into single Staves.

VHen you would reduce or turne any certaine number of Leagues into single Staves. First, set downe the number of Leagues given, then cut off with a dash of your Pen, the three Figures which are next towards your right hand, and multiply the residue which remaine towards your left hand by 3. to the Off-com or Product, adjoyne those three Figures, which you did formerly cut or separate from the rest, and that totall Areare, is the Staves desired: As for Example,

Fourth

Fourth Question of Reduction.

Demand how many single Staves are contained in 975 Leagues.

<i>Manner of Worke</i>	975
	3
	29253000

A Rule to reduce or turne the whole Circumference of the Terrestrial Globe, according to any Paralell or Latitude, into Leagues, Miles or Single Staves.

When you would reduce the whole Circumference of the Globe into any measure that you desire, first, observe the Paralell or Latitude, wherein you desire to know the quantity of Leagues, Miles, or Staves, that should surround the whole body, and then search in my Table of Longitudes, calculated in single Staves, how many will yeeld one Degree in that Paralell; which summe, if you multiply by 36 and to the Off-com adjoyne one Cipher, that totall areare sheweth the single Staves contained in the whole Circumference of that Paralell; which you can reduce into Leagues, and Miles as I have formerly shewed you, which will appeare most plainly by the following Example.

Fifth Question of Reduction.

Demand, how many Leagues is contained in the whole Circumference of the Terrestrial Globe, according to the Circular Paralell, in the Latitude of 50. Degrees.

<i>Manner of Worke</i>	38576
	36
	231456
	115728
	13887360



22		Lea.	Mil.	Stav.
13887		360	4629.	0. 360
3333				

Here

Here in this Question, you may perceive by the manner of worke, that 38576. single Staves, yeeldeth one Degree of Longitude, in the Latitude of 50. Degrees, which Staves being multiplied by 36. and to the Off-com adjoining one Cipher, the totall product amounteth to 13887360. which are the single Staves that will surround or compasse the whole Globe, in that Paralell of 50. Deg. Which Staves, you may see being reduced into Leagues, doth yeeld 4629. Leagues, 0. Min. 360. Staves, which are the Leagues and Staves contained in that whole Circumference, and answereth the Question in those sorts of measure.

If you would know the Myles and Staves that will answer to this whole Circumference of the Globe, onely take the former totall Areare, and cut off with a downeright dash of your Pen, the three Figures towards your right hand, and you have your desire; for the 3. figures cut off from the rest are ever the single Staves, and the residue remaining towards your left hand are the Myles, As for Example, 1. mil. 36. Staves. 138873360.

A Rule to find the Diamiter of any Paralell, having the whole Circumference first given, either in Leagues, Miles, or single Staves.

WHen you would find the Diamiter of any circular Paralell that is described upon the Terrestiall Globe, after you have observed the Latitude or bredth, and how it is Scituated, in respect either of the Pole or Equinoctiall; Then take this course, Multiply the whole Circumference by 7. and divide that product by 22. the quotient will answer your desire; As for Example, wee will of purpose take in hand to find the Diamiter, to the Paralell of 50. deg. which was our sixt and last foregoing Question of Reduction; because, after we have found that Diamiter, by the same Diamiter, we will find againe the Circumference, and so shall need no further illustrating the matter, in regard if you judiciously observe the concurring of the two circumferences severally found

out, it will satisfie you for the surenesse and sufficiency of the worke in all other Paralels, being ever performed by the same manner as is already mentioned.

A Question of finding the Diamiter of any Paralell Circle.

Demand, how many single Staves lengths is contained in the Diamiter of the Circular Paralell, Scituated in the Latit. of 50. deg. from the Equinoctiall.

Here in this Question, you must first turne the whole Circumference of the Paralell in the Latitude of 50. deg. all into single Staves, as hath beene formerly shewed, and it will amount to 13887360. which summe you must multiply by 7. and the product is 97211520. which divide by 22. the quotient is 4418705. and 10. remaining upon the division, which is a Fraction of one Stave : The Question being answered in single Staves, which if reduced into Leagues, yeeldeth 1472. leag. --- 2. mil. --- 705. Sta. :: the true length of the Diamiter desired.

How to finde the whole Circumference of any Circular Paralell by the Diamiter.

Demand, the whole Circumference of the Paralell Circle in the Latitude of 50. deg. the Diamiter being found as before, to be 1472. leagues, 2. miles, 705. Staves ::.

Here first, reduce 1472. leagues, -- 2. mil. -- 705. Staves, the length of the diamiter into single Staves, it maketh 4418705 which summe now multiply by 22. and it yeeldeth 97211520. to this totall product adjoyne 10. the Numerator of the Fraction, and then it maketh 97211520. divide this summe by 7. the quotient sheweth 13887360 which is the whole circumference of the circular Paralell, at the Latitude of 50. deg. the thing desired, and being reduced into Leagues maketh 4629. lea. --- 6. mil. --- 360. Stay. agreeing with the former rule of Reduction.

A Reason of the Worke.

THe Reason why this worke is thus drawne forth in searching for the true Diamiter of any Circle, is in respect, that all manner of Circumferences are more then triple the Diameters, by a certaine fragment or small part, which in the neereſt calculation that I could ever find out, was more then $\frac{1}{7}$ of the ſame: Now take the neereſt rational Proportion, and you will find it as is 22. is to 7. in my Iudgement not poſſible to be drawne neerer.

Theſe Rules of Reduction, which are formerly explained, being well obſerved by the iudicious Practioner, I am certaine, will yeeld him ſuch ſatisfaction in the facile performance of divers matters, which heretofore were moſt obdurate and doubtfull with the utmoſt of his endeavors to find out, that he cannot but yeeld ſome gratefull acknowledgment to the Author of this worke, as the Inſtrument of eaſe to many of his conſolutions.

How to find all manner of Meridional diſtances, according to the Courſes which you are to Saile, in proportion as they are deſcribed upon the Globe.

AFTER you have ſufficiently enformed your ſelfe with the wayes of reduction, it is very proper that you ſhould in the next place apply your ſelfe to find out, how farre you ſhall be ſeparatad from your firſt Meridian, in ſayling upon any courſe, according to the truth diſcovered by the Globe: For I am moſt certaine, that the diſproportion which hath hitherto bene commonly uſed amongſt Sea-men, in drawing forth their Meridional diſtance, (according to the plaine Chart) hoping that it would meeet or concurre with their Latitude found by obſervation, hath bene the chiefe cauſe of ſuch groſſe miſtaking the matter, in many times they have had their expectations deceived 2. or 3. hundred Leag. in ſayling not above 14. or 15. hundred: For in reſpect all the Lynes and parts of the plaine Chart, which hath in all Parallelis, equall degrees of Latitude and Longitude, are in

Generall so grossely false, you must ever expect such preposterious conclusions ingendred by his directions; in the prosecution of long Voyages; wherefore, if you please with patience, first to allow the truth of the premisses, I will then give you directions by the helpe of my former Tables, how you shall find the true Meridionall distance according to the Globe, upon what Course soever you shall Sayle; or in respect of the distance betwixt any two places howsoever Scituated, which I will manifest and make plaine unto you, by resolving of these following Questions; desiring that you would ever have a speciall regard to your Meridionall distance as the maine poynt in Navigation, that will not faile to produce the certaine truth, if with judgement you draw your poynt of Longitude, most exactly to concurre with your daily observation of the Latitude.

First Question, of Meridionall Distances.

THere are two places to the Northwards of the Equinoctiall, one Scituated in the Latitude of 60. deg. the other in the Latitude of 40. deg. and they differ 20. degrees of Longitude in the Equinoctiall, according to the intersection of their severall Meridians. Now I demand, if you were to saile betwixt the aforesaid places, by the most direct course that was possible to be found out, how many Leagues you would allow the Ship to be separated from your first Meridian, according to the Globe.

Here in this Question, first turne the 20. degrees of Longitude distant in the Equinoctiall into Leagues, and they will yeeld you 400. then take 20. degrees, in the Paralell or Latitude of 40. deg. and turne those degrees into single Staves, as formerly I have shewed, and they will yeeld 919240. then turne 20. deg. of Longitude in the Paralell of 60. deg. into single Staves, and there will arise 600000. which two summes containing the single Staves according to each Paralell, adjoyne into one summe, and then it will yeeld 1519240. Now the halfe of this totall sheweth the Meridionall distance in
single

single Staves, that is contained betwixt the aforesaid place according to the proportion of the Globe, which if you turne into Leagues by reduction, will yeeld 153. leag. — 0. mi. — 620 Staves, as appeareth by this Example.

Manner of Worke.

Single Staves contained in the Paralel of 40d. — 919240
 Single Staves contained in the Paralel of 60. — 600000
 Both summes adjoynd into one, will make — 1519240
 The halfe summe in single Staves or distance Meridionall desired. — 759620

You may observe by this Meridionall Question, what Error in your Longitude the plaine Chart would have lead you into, if according to his directions you should have drawne forth your Meridionall distance: For that instrument having in all Paralels or Latitudes, equall degrees of Latitude and Longitude, must of necessity have yeelded you the distance Meridionall, according to the degrees of the Equinoctiall, which sheweth 400. leagues, then which you see most apparently nothing can be more contrary to the truth of the Globe, therefore the intelligent Artift will not endure to follow such directions, for whose sake I have taken thus much paines to prescribe these new Rules, rendring (if rightly used) upon all occasions the most infallible truth.

Second Meridionall Question.

I Demand, if you should saile 12. degrees West, in the Latitude of 80. deg. and then was enforced to Steare due South, untill you come into the Latitude of 50. deg. how many Leagues you would be then distant from your first Meridian.

Here in this Question you have no more to doe but onely to turne 12. deg. in the Paralell of 80. into Single Staves, and it will yeeld 125018, which summe if you reduce into

0 3

Leagues,

Leagues, doth make 41. lea. — 2. mil. — 28. Staves, And now in regard it is supposed, that you are in the Paralell of 50. degrees, having kept the former Course, turne 12. deg. of that Paralell into single Staves, and it will yeeld 4629 12 which if you reduce into Leagues, doth yeeld 154. lea. — 6. mil. — 912. Staves, which answereth the Question, and in the true distance Meridionall in that Paralell, according to the Globe.

Third Meridionall Question.

Demand in the Latitude of 40. Degrees, how many Leagues one degree of that Paralell is lesse, then one degree of the Equinoctiall.

Heere in this Question, you must turne to my Table containing the Difference of Longitude, and there seeke the Latitude of 40. deg. and the three next Columns towards your right hand, will shew 4. Leagues, 2. Myles, and 38. Staves, which answereth the Question; for so much is one degree of Longitude in that Paralell lesse, then one degree of the Equinoctiall.

Fourth Meridionall Question.

There are two places in the Paralell or Latitude of 60. deg. and by the Equinoctiall are Distant each from other 20. degrees, or 400. Leagues: Now I demand, how many degrees and Leagues the aforesaid places are distant from each other, according to their Paralell in 60. degrees.

Here in this Question, search first in my Table calculated in single Staves, how many answer to one degree of Longitude in the Latitude of 60. degrees, and you will find 30000. which Staves, Multiply by 20. the degrees in the Equinoctiall, and they will yeeld 600000. which answereth the Question in single Staves, and being reduced into Degrees and Leagues, as I have formerly shewed you, will produce 20. degrees of that Paralell, or 200. Leagues the proportion desired.

Fifth Meridionall Question.

THere are two places, one lying in the Latitude of 40. degrees, the other in the Latitude of 60. degrees, and are distant 15. degrees of Longitude, by the degrees in the Equinoctiall.

I demand, how many Leagues are contained betwixt the Meridians of those two places, according to their severall Paralels.

Turne one degree in each Paralell into single Staves, and them multiply their products by 15. the deg. of the Equinoctiall, and you have the single Staves contained in each Paralell, which you know how to reduce into Leagues, and in this Question, the Paralell of 60 deg. will yeeld you 150. leagues, and the Paralell of 40. degrees will yeeld 229. lea. ——— 2 mil. --- 430. Sta. --- which are the true distances in each places Paralell, according to the proportion of the Globe.

There are infinite other Questions which you may daily performe by the helpe of my former Tables, with so much ease that you cannot allow the use of the plaine Chart, (to exceed them in that poynt) yet I am certaine you cannot now choose, but perceive how farre the Conclusions wrought by the former Directions doth excell the plaine Chart, which you see apparently hath need of Crutchcs, being lame in all his Lineaments.

How to finde the Course or Point of the Compasse, when you are so Sayle in any Paralell, according to the Distance taken by the Arch of one of the greatest Circles.

Having thoroughly acquainted your selfe with the true use of my former Tables, the rules of Reduction, the true quantity of Leagues, Myles, and Staves lengths, which you

you must Sayle upon all Courtes, before you raise or deprese the Pole one degree; As likewise how much you shall varie in each degree from your first Meridian, the reason of the measure drawne from the *Spanish* accompt, and all the matters in generall formerly explained, then if your Course be according to any Paralell, you may proceed to find out the Poynts of the Compasse by which you must steere according to the plaine of the great Circle extended, betwixt any two places so Scituated; but if the two places differ much in Latitude as well as in Longitude, then it is most vaine to endeavour to prosecute your Course by the Compasse according to the plaine of that great Circle extended, as shall be at large explained where I will shew you how to order your affaires according to such manner of Courtes; if they differ but a small matter in Latitude, then your paralell direction serveth.

A Paralell Question.

I Demand the Course and distance according to the Arch of one of the greatest Circles extended, betwixt the Island called by the name of *Shotland*, being one of the Isles of *Orkney*, which is Scituated in the Latitude of 60. deg. to the Northward of the Equinoctiall, and hath 21. degrees of Longitude, and the great Island called *Desolation*, which lyeth in the way as you saile to *Danes Straights*, and is also Scituated in the Latitude of 60. deg. of North Latitude and hath 33 0. deg. of Longitude.

To prosecute your course in this Question. and other of like Nature, according to the position of each severall Angle, that the great Circle extended betwixt the aforesayd places produceth, I know will prove so troublesome, that the Mariner I am certaine will not endure such directions, and although he should take such paines, the profit arising will be but a poore reward, in regard the Ship will not nor cannot be constrained to observe them in her Course through the Sea: where-

Wherefore leaving such nice conclusions, to the Practitioners in quiet Studies on the Land, I will shew the Mariner a facile way how hee shall find out a Course or poynt of the Compass according to the distance discovered by the plaine of the great Circle extended, and yet in the whole Course shall not alter the poynt of the Compass above thrice, which hee may very easily constrain the Ship to performe as shall be now explained according to the Question propounded.

First then, to resolve the Question, you must find the true distance betwixt the Ile of *Shotland*, and the Island called *Desolation*, according to the Arch of a great Circle, as hath bin shewed heretofore, which will appeare by worke, is 199.3 leagues. Now turne halfe the distance of deg. that is contained betwixt the aforesaid places into Leagues, as hath likewise beene formerly shewed, and there will arise 520 from which if you subtract 496.7, the distance by the great Circle there remaineth 13. halfe leagues, which sheweth that you will make your way so much shorter, then if you should saile by your East and West Paralell. Now then turne the Leagues found by the extension of the great Circle into single Staves, and it will yeeld 1489500. then reduce the 520 Leagues, the distance in the Paralell, and it yeeldeth 1530000. single Staves. Now suppose you were beginning to shape your Course from the Island of *Shotland*, to saile to the former Island called *Desolation*; you may in the first place very plainly perceiue that if you should perceiue, that if you should saile any thing to the Southward of your Paralell, you must needs make your way longer, in regard all Paralells betwixt your Latitude of 60. deg. and the Equinoctiall retaine a bigger proportion in respect of the Meridian; but all Paralells, contained betwixt your Latitude and the Pole yeeld a lesse proportion; therefore you may conclude according to reason, that you must ever shape your Course to the Northward of your Paralell if you intend to saile according to the plaine of the great Circle extended: Now then being assured you are to saile to the North:

ward of your Paralell, you must find in this manner the greatest point of North Latitude that you are to touch; at first, turne all the degrees of the Meridian which are contained betwixt your Latitude of 60. degrees, and the Equinoctiall into single Minutes, which you may easily performe at all times, if you multiply the degrees of Latitude by 60. the product yeeldeth your desire; As in this Example, 60 d. of Latit. multiplied by 60. will yeeld you 3600. which are the single Minutes desired: Now apply the backe rule of proportion in this manner, saying, if 1530000. the Single Staves contained in the distance by the Paralell, yeeld 3600. minutes of the Meridian, what shall 1489500. single Staves, the distance by the Arch yeeld, which if you worke according to the reversed rule of proportion, will produce 3697. minutes of the Meridian, which minutes if you divide by 60. the quotient sheweth 61. deg. and 37. remaining upon the division which are minutes; Therefore you may now conclude, that the point of your greatest North Latitude which you must touch at in this Question, is 61. deg. 37. min. Now to find the points of the Compass which you must direct your course by, according to the plaine of the great Circle extended; First divide 1489500. the single Staves in the distance by the great Arch into three equal parts, which doth represent the three severall points of the Compass by which you are to saile, and in this question you will find the one third part is 496500. Staves, then take the odde degrees and minutes of Latitude, which exceed your Paralell of 60. deg. namely 1. deg. 37. min. and turne them into minutes, and they will yeeld you 97. Now apply the plaine rule of proportion, saying, if 97. minutes of the Meridian yeeld 496500. single Staves upon the course, what shall 60. Minutes, being one Degree of the Meridian yeeld, and the worke will shew you 307164. Staves, which if you reduce into leagues, amount to 102. leagues, one mile, and 64. Staves, which are the Leagues and Staves which you must saile upon the Course before you shall raise the Pole one degree: Now then

then, if you repair to my table which sheweth the Leagues, Miles, and Staves, which you must saile upon any poynce of the Compass to raise the Pole one degree, and there make application, searching out what poynce will comethe nearest in his proportion to 102. leagues, i. Mile, 164. Sta. you will find it is West and by North, upon which Course you must Saile 496500. Staves, which will raise the Pole, 1 deg. 37. min. and toucheth the Paralell accordin g to the poynce of your greatest Latitude formerly found, concluding one poynce of the Compass by which you are to saile, and yeelding you the one third part of your distance to be expired; Now you must saile 496500. Staves, which is one other third part of the distance due West, keeping your selfe exactly in that paralell of 61. deg. 37. min. untill that third part be also expired, then in regard your first course was W, by N. you must saile 496500. Staves West by S. untill you find by your observation that you are come againe into your first Paralell or Latitude of 60. degrees, and then is this third part which is the last of the three also expired, and now you may be most confident that your Ship is close aboard the great Iland called *Desolation*, which is the place you were to saile unto: and you have made your Course shorter by 3. leagues then it would have beene, if you had sayled according to the direction of your East and West Paralell: besides the great ease and helpe which you have according to this kind of sayling, to accompt your Ships way through the Sea by your dayly observations, in regard it plainly appeareth, that you shall raise and depresse the Pole upon this whole course neare upon 5. deg. of Latitude, I know the ingenious Artift will quickly discern, there is sufficient reason to satisfie (it is worth his labour) to prosecute his Paralell courses, according to these plaine and easie directions, which cannot in any kind seeme obscure or darke to his understanding, unless perchance he should not be over-well acquainted with *Regula reversa*, or the backe rule of Three, which indeed is almost excellent Rule, both to resolve divers questions of Na-

Manner of Worke.

If 9. men require 6. dayes, what shall 3. men require?

$$\begin{array}{r} 6 \\ 54 \overline{) 324} \end{array} \quad \begin{array}{r} 18 \text{ dayes.} \\ 54 \overline{) 324} \end{array}$$

Here you see, by the manner of worke used in the versed Rule, that 9. the first number being multiplyed by 6. the second number doth yeeld 54. which being divided by 3. the last number, the Quotient giveth 18. which are dayes; and answereth the Question. Knowing the excellent Conclusions performed by this Rule, I could not but give the Sea-men this little taste, which I am certaine hath the true relish, and perchance may stirre up their appetites with a longing desire, freely to feast on such faire and pleasant fruits.

The Order to be observed in your Sayling betwixt any two places that are Situated in severall Latitudes and Longitudes.

When you are to sayle betwixt any two places assigned, that differ both in Latitude and Longitude, after you have found the true distance according to the Arch of a great Circle extended, you must not imagine to prosecute your course according to the position of each severall Angle, that the Ship must be constrained to performe, if you should sayle by the plain of that great Circle so extended: for first, you will gaine so small a matter in the shortning of your way, that it will not be worth looking after. And then must be enforced to steere (point blanke) as I may rearme it, with your place assigned; concluding your Latitude and Longitude in one minute, which we all know (that have experience at Sea) is not the best course to be observed; for if we should misse the least matter either in observation, or accompting our Meridionall distance. In sayling to

alone Jland in the Ocean Sea, we might quickly with our over-nice Conclusions, shoot beyond the Marke; which would redound more to our discredit, then the profit of so prosecuting our course, would ever promise us.

Therefore, when you are to sayle according to such distances: first, find out the true quantity of Leagues, according to the great Arch extended, which Leagues turne into single Staves; then consider the Latitude of both places, subtracting the lesser from the greater; if both places be situated eyther to the North-ward, or South-ward of the Equinoctiall, and the remainder will shew you, how many Degrees and Minutes, you must raise or depress the Pole in your whole course. But if one of your places should lye to the Southwards off the Line, and the other to the Northwards, then adde the lesser Latitude to the greater, and the Off-com or totall summe, sheweth how many Degrees and Minutes you will raise or depress the Pole, upon that whole Course; which Degrees and Minutes so found out, turne all into single Minutes, then take the Minutes contained in one Degree of the Meridian, which are ever 60. with which summe, multiply the single Staves contained in the distance found, by the great Arch; and then take the Product, and divide it by the single Minutes, contained in the difference of your Latitude, and the Quotient will shew you how many Staves you must sayle, before the Pole shall be raised or depressed one Degree: which Staves, if you reduce into Leagues; and then compare those Leagues with the Leagues answering in my former Table, to each point of the Compass, in raising the Pole one Degree; you will finde the point of the Compass by which you are to sayle, as shall appear by this Example.

Question.

I Demand, the Distance and Course by the point of the Compass that you must steere upon, in sayling betwixt the
Heads

Head-land in the West of *England* called the *Lyzard*, lying in 50. Degrees of North Latitude, and in 16. Degrees of Longitude; and the Island called the *Barbadoes* in the West-Indies, being situated in 13. Degrees of North Latitude, and in the Longitude of 313. Degrees.

Here in this Question, first finde out the distance by the great Arch, which will appeare to be 1257. Leagues, and being turned into Staves, doth yeeld 3771600. then subtract 13. deg. the lesser Latitude, from 50. deg. the greater, there remaineth 37. degrees, which turned into single minutes, will yeeld 2220. Now if you take 60. minutes, which make one Degree of the Meridian, and multiply 3771600. the Staves contained in the distance by the great Arch, the Product will amount to 226260000. Staves; which Staves, if you divide by 2220. the minutes that arise in 37. degrees difference of Latitude, the Quotient sheweth you 101918. Staves, and 1040. remaining upon the division, which is a fraction of no consequence. Therefore if you turne 101918. Staves into Leagues, it yeeldeth 33. leag. 2. min. 918. Sta. Which sheweth you, that you must saile so much upon your Count, before the Pole shall be depressed one Degree. Now then if you repaire to my Table, which giveth the Leagues upon all points of the Compass that you must saile, before you raise or deprime the Pole one Degree, and there observe which of them answereth neereſt to 33. leag. 2. min. 918. Staves, you will finde S W 1 point Westerly, which is the point of the Compass, which runneth right upon the Island, according to the Rumb extended betwixt the *Lyzard* and the *Barbadoes*. But you know, in sayling betwixt these two places, we haule at first a farre more Southerly Course, in regard we would get as much benefit as possible of the Trade-winde, as we learne it, which ever bloweth betwixt the North and East, when you are neare the Tropickes, and then we haule away more Westerly; yet still being carefull to get into our Latitude, 50. or 60. Leagues short of the Land, that we may be sure not to over-shoot the place, which

which indeed is the best and surest way of sailing betwixt the aforelaid places. For which manner of proceeding, we have experience, for our infallible and vncontralable Tutor, which did not dwell all his dayes within the confines of a quiet Cloister; for from thence there could never as yet be drawne forth such directions. Therefore, the industrious endeavors of the judicious Practitioners in the famous Art of Navigation, must reape as in all right, & gratefull acknowledgemēt of their great attempts, for finding out both this and diuers other matters, which no Study-Rules could ever reach so farre, to paralell their experimentall Conclusions. Therefore, we may iustly joyne Art and Experience, as the two equal Sisters, which made the wreath of Renowne, that bindes the Browes of all generous and worthy Navigators. But to speake a word or two more concerning the former worke contained in this Chapter: You may understand, that the poynt of the Compass may also bee found out, according to the distance betwixt any two places by your Meridionall proportion, as we will prove by the former Question, in this manner.

First, observe all the Degrees of Longitude, contained betwixt the *Lizard* and the *Barbadoes*, and you will find they are 63. deg. Which Degrees turne into single Staves, according to each places Paralell, and there will arise in the paralell of 50. Degrees 2429721. Staves, and in the Paralell of 13. deg. there amounteth 3683106. which two summes contayning the single Staves, according to each places Paralell, adjoyne into one summe, and it will make 6112827. Staves. Now take the halfe of this last summe, which is 3056413. and it sheweth you the single Staves contained in your Meridionall distance according to the Globe; therefore divide these Staves by 37. Degrees, the difference of your Latitude, and the Quotient will yeeld you 82605. Sta. which being reduced into Leagues, doth yeeld 27. leagues, 1. mile, 605. Staves. And now if you repaire to my former Table, and there search what Meridionall distance answereth to 27. leagues 1. mile, 605. Staves. You will find, that
S W.

S. W. 1. point Westerly, answereth your desire, thus you have two infallible wayes, to find out the point of the Compass according to all distances; if you desire a farther reason of this manner of work, you must understand it is onely drawne forth from the plaine rule of Proportion in both the wayes: For as 37. degrees, the difference of Latitude is to 841900. Staves the distance by the Arch, so is one degree of the Meridian to the Course or point of the Compass, which yeelded 33. leag. 2. miles, 918. Stav. which being compared in my Table S. W. 1. point Westerly, sheweth the same quantity: then the Meridionall proportion is, as 37. degrees difference of Latitude is to 3056413. Staves distance Meridionall so is 1. degree of the Meridian to 82605. Staves which make 27. leag. 1. mile 605. Stav. and being compared to the Meridionall distance in my Table S. W. 1. Westerly, yeeldeth the same proportion, this is sufficient for those which desire a farther reason of the former worke; and so I will leave this matter to their farther practice, and will now proceed to shew the use and projections of the Crosse-staffe and Back-staffe; and so I will make a full conclusion of this my whole worke.

The Projection of the Crosse-staffe.

THe Crosse-staffe is onely a Geometricall Arch contrived into a straight line upon the graduated Staffe, which when the Crosse is applyed giveth the content of the (Angle) with as much certainty and truth as the Arch or Quadrant doth, and it is projected or framed, in this manner.

You must have a paire of beame Compasses of a large size, as 22, 14, or 16. Inches; with those Compasses upon a plaine and exact levill board or Table, sweep an Arch of a Circle something bigger, then a Quadrant, and let his Semidiameter be as bigge as with conveniencie your board or Table will containe, the bigger the better: Now with the same extent that you swept the Circle or portion of the Arch, set one foote in one of the Arches extremes, and with the other

make a small prick or mark in the same Arch, then take halfe the distance of those two prick or marks, and make a third marke in the same Arch, then laying a straight ruler to the third marke and the Center, draw a straight line, and so likewise betwixt the first marke and the Center draw a straight line: so shall you have an exact Quadrant or fourth part of a Circle contained betwixt those two Semidiameters: Now extend one of those Semidiameters, to what length your board will permit, as 3, 4, or 5, fote, and from the intersection of the other Semidiameter with the Arch, taile a perpendicular which may runne exactly Paralell to the Semidiameter extended, and make them equal of one length, then divide your Arch into two parts, drawing a Line from the Center through that division, untill it intersect the former Paralell, then divide the halfe Arch into three equal parts, drawing Lines through those divisions to the Paralell as before, and then divide those three parts into other three parts, and those 9. parts each into two parts, so have you 18. parts, and those 18. each into 5. so have you 90. parts: Now draw lines through each of those divisions, from the Center to the Paralell, as before: And so have you a Geometricall projection, for the making of all sorts of Crosse-staves according to the length of theyr Crosse or Transsumes; onely for your more easie understanding, and that you should not mistake when you are to Graduate a Staffe by this projection observe this Method

If you would have a large Staffe containing large Degrees, all your Transsumes or Crosse must be as large as your projected Quadrant is of capacity to beare, namely the halfe of your 90. Transum may be the length of the Semidiameter to the intersection of the Arch, but longer it must never be, for that is the greatest and largest degrees, that any Transum can shew with truth upon the largest and longest Staffe that such a projection may produce, but for the other Transsumes or Crosse, namely your 60. and 30. will have degrees large enough, if your 60. Transum be one halfe the length of your 90. and

90. and the 30. one halfe the length of the 60. most gentle
 29. When you have a Staffe or graduare, and that you have ap-
 pointed the length of his Transfume according to your mind
 remember alwayes to take the exact halfe of each Transfume
 and draw a Paralell to your extended Semidiameter contain-
 ing that distance: And observe how that Paralell intersect-
 eth each line drawne through each division of the Arch, and
 they will be the degrees of the Angle made by your Crosse in
 observation, in all respects equal to the degrees of a Geome-
 tricall Arch, which is the matter desired, and is sufficiently
 manifested, for the capacity of any man that will be the least
 industrious.

Now a word or two of the reason of this Projection, and
 so I will proceed to shew you how to handle him at Sea, to
 gaine the Altitude either of Sunne or Starres: The reason of
 this projection may best be drawne from the consideration of
 a right angled *Isofcheles*, for when your Crosse of 90. deg. in-
 tersects that degree upon the graduated Staffe, your Crosse
 is the subtending side or Hypotenuse, and your two visuell
 lines are his containing sides, namely the Line intersecting
 the Horizon, and your Zenith perpendicular; and the Angle
 intersected by those two lines falling or joyning with your
 Eye, and the Center of the Staffe is a right Angle containing
 90. deg. Now from this I gather, if any Angle at the Center
 of the Staffe must grow more accute or Sharpe, it must pro-
 ceed by running or sliding the Crosse farther from my Eye,
 and not by drawing it nearer for then I should have my An-
 gle more obtuse or blunt then the right Angle of 90. then
 which, nothing can be more absurd, then to measure beyond
 my Zenith in taking the Altitude or Sunne or Starres, where-
 fore considering I must slide the Transfume forwards, if I ob-
 serve any body Scituated in the Heavens of lesse Altitude
 then my Zenith, and that my Angle from the Center of the
 Staffe, and my Eye, will grow more Accute or Sharpe, I per-
 ceive my rightangled *Isofcheles* is changed into a rightangled
Scatenum, and that my Crosse is now the perpendicular line

falling from the Body observed, and intersecting my visual Line with the Horizon at a right Angle, and that my other visual Line extended to the Body observed, is the Subtending side, or *Hypotenuse* of that Angle: Therefore, I divide the Lines drawne through an Arch exactly divided, are only visual Lines of the Angle contained, and that a Crosse may be fitted upon a Staffe, to intersect each severall visual Line with a right angled *Scale*, untill my visual Lines containe a right Angle, and the Crosse be the subtending side, or *Hypotenuse*, and then I have a right angled *Isosceles* as afore; he that can draw forth his Imaginations more lively concerning this matter, I freely give him leave, &c.

How to observe the Altitude at Sea, with the Crosse-Staffe.

When you would find the Altitude of eyther Sunne or Starre, by the ayde of your Crosse-Staffe, completely fitted with his Transunimes, take your graduated Staffe, and one of your Transunimes, or Crosse, which is most apt or fit for the Altitude desired; as if it be any great Altitude, your 90. Crosse, if a smaller your 60. Crosse, and if the Body to be observed be neere the Horizon, then your 30. Crosse.

As for Example. Suppose you were comming in for the *Sleeve*, and would observe the North-Starre, take your graduated Staffe, and because the Altitude is none of the greatest, employ your 60. Transunime or Crosse, thrusting your Staffe through his Socket, and then place the end of your Staffe, which is the Center to your 90. Transunime, in orderly sort; joyning it to the corner of your right Eye, winking with the other, then slide the Crosse too and fro, untill you can see onely the Center, or middelt of the Starre, equall with the upper edge of your Transunime, and that at the same instant you perceive the lower equall, or intersecting the Horizon; which when you have found in most exact manner, rest from farther

labor:

labour; and onely looke where the nearest plaine edge of the Crosse falleth or cutteth in your graduated Staffe, which Conclude according to the number so found, is the Angle contained, or altitude of that body observed. In the same sort, you may find the Angle or Altitude of all bodies situated in the Heavens, with your graduated Staffe, and the Transims or Crosses rightly applied: But I hold, after my Altitude is once greater then 60. deg. your Crosse-staffe applyed according to the former observation, is very difficult and doubtfull to handle without great errour; because the Altitude of the Body, and the intersection of the Horizon, are so farre distant, that your visuall Lines, can very hardly concurre with exact truth in one instant of time, therefore for the observing of the Sunne to the Southwards, your Crosse-staffe is of little use, except you have veynes, or contrive it to observe with the shadow, turning your backe towards the Sunne, as you doe with your Back-staffe, but for all Stars that are not very high above the Horizon, especially if they exceed not 30. degrees there is no instrument under the Heavens, to be compared with the Crosse-staffe at Sea, because then his Degrees are so large, that any sensible distance will easily appeare in single Minutes, and with a little labor you shall be in no Latitude of the world; but you shall have divers such Starres come in rule every night, if you will make heedfull observation. Therefore the excellent operation of the Crosse-staffe, can never be disparaged, if rightly applyed.

Of the Back-staffe.

THe Back-staffe, is onely a Quadrant, or fourth part of any Circle divided into 90. Degrees, and it mattereth not which way the account of Degrees beginneth to be numbred, that is, whether your Zenith conclude 90. or the Horizon, for they will come to one matter: if you count the Degrees containd betwixt the two sliding veines in observation, to be the Altitude according to the cutting of the

shadow.

shadow, and the complement, or that which remaineth without each veine, is alwayes the Zenith distance of the Sunne, according to the Altitude taken; but they are commonly graduated, concluding 90. in the Zenith, which is not the best and readiest way for the Mariners use, but would be more easie (though nothing difficult neyther way) if they concluded 90. in the Horizon. They are projected of divers formes and fashions, but the general Rule for them all, is that they containe exactly a Quadrant, or fourth part of a Circle, betwixt your visuall Line that intersecteth the Horizon, and your Zenith perpendicular; but of all Back-staves J hold the double Arched projection to be the best, and most usefull at Sea, therefore J will here shew how he is framed.

The Projection of the Back-staffe.

THE Back-staffe is so called, because you turne your backe towards the Sunne in observation, and your visuall Line intersecting the Horizon, with the shadow of the Sunne concurring at one instant, giveth the Angle or Altitude desired. Now to frame the Back-staffe with a double Arch, take your large Compasses afore-mentioned, and upon some plain board or Table, make an exact Quadrant, as hath beene formerly shewed in projecting the Crosse-staffe, containing about 6. or 8. Inches Semidiameter, then be very circumspect to divide that Quadrant into 90. Degrees, as hath been shewed before; Now extend your Semidiameter, which intersecteth your Arch, where the 90. Deg. are begun to be numbred, to two or three foot, or at pleasure, and as your materials will permit: Then take the length which you intend to have your Staffe, and draw a Line from the Center, intersecting the Quadrant at 30. deg. of the same length, now sweep an Arch betwixt the end of that extent, and the Semidiameter extended; and so your Back-staffe is finished. If you divide this 30. Arch exactly into deg. and minutes, which is the Arch, whereon in observation you must place your sliding veine with the Sight in it, but the other Arch needeth no more divisions.

divisions, then whole Degrees; because thereon you must place your fixed veine, which will cut the Horizon according to the shadow of the Sunne, and therefore needeth but onely to be placed at any of the whole degrees, as occasion shall require, and the other sliding veine conveying your visuall Line, through the Center of the Staffe, or Horizon veine, will give the Angle or Altitude of all manner of Instruments at Sea that I have met withall, the most exact and plaine.

To find the Altitude of the Sunne at Sea, with the Back-staffe.

HAVING your three Veines fitted to your Staffe, namely, your Horizon veine, with a slit exactly joyning with the Center of the Staffe, and one sliding veine placed upon the 30. Arch of your Instrument, which hath a slit likewise to transport your visuall Line through the Horizon veine at the Center, and one plaine veine placed at any of the degrees in your 60. Arch, as your Altitude shall require. For example, Suppose you would know the Altitude of the Sunne when you are certaine she will be mounted upon her Meridian at least 70. deg. above the Horizon: First take your projected Staffe, and put on your Horizon veine, carefully regarding, that the slit and the pricke at the Center concur in one, then take your fixed veine, and place it upon the 60. Arch, either at 70, 80, or 90. but nearer then 70. you must not now place it, because the Angle is like to be about 70. Degrees, and if you should place it at lesse, the 30. Arch will not be capable to resolve the Angle: Therefore here in this Question, suppose you place the fixed veine with his upper edge, exactly cutting at 80. Degrees in the 60. Arch. Then take your sliding veine with the slit in it, and place it upon the 30. Arch, moving it higher or lower as occasion requireth, untill you find the visuall Line, transported through the slit of the Horizon veine, and that the upper edge of your fixed-

The Navigator.

Each-veine, & caletteth his sliding-veine in the slit of the Horizon-veine, and then he putteth his sliding-veine in perpendicular to the Horizonall Circle of the Meridian, and the Staffe, and so keepes your Instrument, with the backe of your sliding-veine, untill you have the Sunne upon her Meridian, or greatest Altitude for that day: then observe in your 30. Arch, what Degree and minute the slit in your sliding-veine cutteth, and compute all the Degrees contained from the upper edge of your fixed-veine to that intersection: For the true Content of the Angle, according to the Altitude of the Sunne taken that day in the afore-layd place. As in this Example, Admit after the Staffe rectified in all respects as before, that the Sunne upon her Meridian, your sliding-veine runneth with his slit just in 10. Degrees of the 30. Arch, therefore you must compute from the upper edge of the fixed-veine, placed at 80. Degrees, to ten Degrees the former intersection, and it will yeeld you 70. Degrees, which you may safely conclude, is the Angle or Altitude desired.

And so I will conclude the whole Worke herein contain-
ed, beginning with the Practicke part of Navigation, in
working a Ship according to all weathers, and ending with
the Practicke in Projecting, and using the Back-Staffe: Desir-
ing that none out of malice, will seeme over-suddenly to
take in hand to mend the matter which I have now writ
of, lest they shew shew of the Markes, and to loose their
Credit by controlling, when they are not able to performe
the like.

And so Everwell

FINIS